Working Paper

Assessment of the Influence of Forest Exploitation on Species Biodiversity in the Russian Far East

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Foreword

Siberia's forest sector is a topic which has recently gained considerable international interest.

IIASA, the Russian Academy of Sciences, and the Russian Federal Forest Service, in agreement with the Russian Ministry of the Environment and Natural Resources, signed agreements in 1992 and 1994 to carry out a large-scale study on the Siberian forest sector. The overall objective of the study is to focus on policy options that would encourage sustainable development of the sector. The goals are to assess Siberia's forest resources, forest industries, and infrastructure; to examine the forests' economic, social, and biospheric functions; with these functions in mind, to identify possible pathways for their sustainable development; and to translate these pathways into policy options for Russian and international agencies.

The first phase of the study concentrated on the generation of extensive and consistent databases for the total forest sector of Siberia and Russia.

The second phase of the study encompassed assessment studies of the greenhouse gas balances, forest resources and forest utilization, biodiversity and landscapes, non-wood products and functions, environmental status, transportation infrastructure, forest industry and markets, and socioeconomic problems.

This report, carried out by Olga Uphyrkina from the Biology and Soil Sciences Institute of the Russian Academy of Sciences during her stay at IIASA in 1996, is a contribution to the analyses of the issue of biodiversity.

Contents

Abstract

Deforestation is the primary cause of species's habitat losses and, as a consequence, a decline of the number of individuals of populations and the size of distributions of forest-dwelling animal species takes place.

In the Russian Far East recent forest exploitation has affected populations of several vertebrate species, and brought them to the edge of extinction. Current foreign investments in forest enterprises, and thus an expected rapid industrial development of the forest sector in the region, do not give hope for the threatened species survival unless urgent protection measures are taken.

In this particular study, assessments of the influence of forest exploitation has been done by studying the development of a couple of so-called key-stone species, namely the Amur tiger and the Amur leopard, the Himalayan Black Bear, and four endangered species of birds and bird communities. A detailed analysis of the species development has been carried out with respect to historical trends in distribution and population size, current status and future trends, main factors of disappearance, relationship to forest practises, and existing and future protection measures

Additionally, short assessments of the recent forest management, the scale of current foreign investments in forest enterprises, and an overview of the present biodiversity status and the protected area system in the region have been carried out.

1 Introduction

1.1 Background information

The Russian Far East (RFE) is one of Russia's richest regions with respect to both biodiversity and natural resources (Ministry of Environmental Protection and Nature Resources of Russian Federation, 1995). The geographic position, geodynamic, and climatic particularities have resulted in wonderful complexes of flora and fauna. In the juncture between boreal and southern subtropical forest ecosystems, tropical plants and northern coniferous trees are found wrapped around each other in perfect symbiosis.

The Siberian taiga, which stretches from the Urals to the Pacific Ocean, contains about 50% of the world's coniferous forest and nearly 20% of the world's growing stock (Shvidenko and Nilsson, 1994). The Siberian forest helps to mitigate global warming and constitute a natural heritage of international importance. These forests are a treasure trove of biological diversity, especially in the Ussuriland forests of Sikhote-Alin mountain range in the Russian Far East. This area contains over 3,000 higher plant species and is recognized by IUCN as a Center for Plant Diversity (World Bank, 1995). These forests contain an array of medicinal plants, and are the home range of the critically endangered Siberian tiger (of which only 250 are left in the wild), the Amur leopard (less than 30 animals exist), the Himalayan black bear and many other endangered species (Primorskiy Environmental Protection Committee, 1995).

Siberian forests have always been the object of exploitation by the Russian timber industry. The Ussuriland forest, covered with cedar, is both ecologically and culturally vital to the RFE. However, logging over the last 40 years has severely impacted much of the Ussuriland Korean pine-broadleaved forests. Russian logging enterprises practiced destructive "high-grading " by logging the biggest and the best trees from each area, and the dominant species of the ecosystem. Nevertheless, the threat of logging in the RFE is now even greater.

In the RFE, the situation has deteriorated since 1990, when the Russian eastern borders were opened, and the huge territory became available for foreign investments and international commercial exploitation. Now the RFE is one of the most dynamic regions in Russia's changing economy, and the latest member of the Pacific Rim community. Due to the tremendous stock of natural resources, the geographical position of the region, and the potential profitability the Far East has attracted a lot of businessmen from Korea, Japan, China, North America, and Europe. The main interest by the multinational companies has been focused on investments in forest enterprises. By opening the rich territories to foreign investments, the Russian Government sees timber as a quick source of cash to prop up an economy that continues to flounder. Thus, the forest of the RFE may be threatened by large-scale logging, as federal and regional governments struggle to find a short-term answer to their severe economic problems. They do not pay attention to the fact that the Ussuriland forests also offer a potential for long-term environmentally sustainable economies, based on non-timber forest products.

With reference to the above-mentioned, over the last five years forest-dependent animal and plant species populations in the RFE have declined very rapidly as a result of both poaching and habitat fragmentation and destruction. About 160–170 individuals of the famous Amur tiger has been lost between 1990 and the summer of 1994, which has reduced the population from over 400 to 250 individuals. The last natural habitat, the Sikhote-Alin taiga, is being destroyed very quickly by commercial harvesting of Korean pine and Japanese oak, which are the main components of the tiger's forest habitat.

Another exotic predator of the Far East, the critically endangered Amur leopard, is in an even more critical situation and is suffering from anthropogenic activities. Today, only 26–30 leopards are estimated to live in the wild, and are confined to the area of the Kedrovay Pad' *Zapovednik*. Only 10 purebred individuals live in the zoos of the world.

The loss of natural habitat has diminished the Himalayan black bear, the Mongolian goral, the musk deer, and many other mammal species and birds of by more than half and have led to alteration of the bird communities.

1.2 Objectives of the study

The main objectives are: Based on the key-stone species, the Critically Endangered Amur/Siberian Tiger (*Panthera tigris altaica*), the Critically Endangered Amur Leopard (*Panthera pardus orientalis*), the Endangered Himalayan Black Bear (*Ursus thibetanus*), and some endangered species of birds and bird communities:

1. To give an analysis of the influence of the recent industrial development in the Russian forest sector with respect to the status of species biodiversity, and to make projections on the future development.

2. To analyze existing protection measures, and propose future protection needs for species conservation.

To reach these goals, the following issues have been investigated for each species:

- Historical trends of the size of distributions and populations.
- Current status and future trends.
- Driving forces for extinction.
- Relationship between development of the species and logging and forestry management practices.
- Habitat protection needs for conservation of the species.

To make the analyses surmountable, short assessments have been carried out with respect to current biodiversity status, protected area system, and recent and future developments in the forest sector.

1.3 Research methods

The work has been done, based on an analytical review of existing literature; reports of different international agencies (World Bank, etc.), national (Ministry of Environmental Protection etc.) and regional organizations (Primorskiy Environmental Protection Committee), and based on communications with natural reserve staff, scientists from the Institutes of the Far East Division of the Russian Academy of Sciences, staff from the international projects: *Siberian Tiger Project; Environmental Policy & Technology Project; Siberia Forest Protection Project.*

2 The Russian Far East: General Assessment of Current Biodiversity Situation

2.1 Introduction

The Russian Far East covers 6.22 million km^2, which is 36,4% of the total Russian Federation territory (Figure 1). It corresponds to about two thirds of the territory of the United States. The Far East economical region includes several administrative subregions, which are shown and listed in Figure 1.

The natural zones of the RFE varies from coniferous-broadleaved forest in Primorskiy Kray and along the Amur lowland, over conifer forests (taiga), and to north Arctic tundra.

The Far East is one of richest regions in Russia in term of natural resources. Industrial development of the region has already disturbed large areas of the territory. Today the rate of industrial development is increasing rapidly. As a consequence, some species of plants and animals have been greatly depleted or even pushed to the edge of extinction.

2.2 The RFE – specific features of biodiversity

The Russian Far East, especially its southern part, is a region of unique biodiversity. The region possesses large, rich, and unusual temperate forests. These forests, combining features of the boreal taiga and plants of the southern subtropical forest, results in unusual ecosystems. These ecosystems are characterized by polyclimatic structures, extreme flora and fauna richness, a combination of an intensive speciation process and old community conservation, high biological productivity, and different complex types of forest development. Altogether the forests play an important role not only locally, but also in the whole Pacific Ocean Region.

These forests are now virtually unique, as similar communities have been largely destroyed in China, Japan, and in the Korean Peninsula.

Much of the Amur-Sakhalin region escaped the glaciation period, and by that formed a climatic refuge for numerous species, communities and ecosystems, that are now found nowhere else. Compared to other temperate ecosystems, the level of endemic plants and invertebrates present in the region is very high. The Sikhote-Alin Mountain area contains over 3,000 higher plant species, and is recognized by UICN as a Center for Plant Diversity (World Bank, 1995).

Some of the plant species are ancient, originating in the Tertiary Period, for instance, Yew (*Taxus cuspidata*), Amur cork tree (*Phellodendron amurense*), Aralia (*Alaria cordata*), Ginseng (*Panax ginseng*), Limonnik/magnolia-vine (*Schisandra cinesis*), Dimorphant (*Kalonapax septemlobus*), Microbiota (*Microbiota decussata*), different species of Willow (*Salix*), and different Fern species.

One third of all vertebrates present in the former Soviet Union, live in the Far East (World Bank, 1995). Numerous animals and plants are endemic to this bioregion, both within Russia and globally. Of these, many are rare and threatened with extinction. Examples of such animals are: Amur or Siberian tiger (*Panthera tigris altaica*), Amur leopard (*Panthera pardus orientalis*), Musk deer (*Moschus moschiferus*), Himalayan bears (*Ursus thibetanus ussuricus*), Amur Goral (*Nemorhaedus caudatus*), Amur forest cat (*Felis euptilura*), Steller's sea eagle (*Haliaeetus pelagicus*), Siberian spruce grouse (*Falcipennis falcipennis*), Japanese crane (*Grus japonensis*), White-naped crane (*Grus vipio*), Blakiston's Fish Owl (*Ketupa blakistoni*), Brown hawk owl (*Ninox scutulata*), Amur sturgeon (*Acipenser medirostris*), 13 species of freshwater mussel, 2 spectacular species of swallowtail butterflies (*Sericinus montela* and *Atrophaneura alcinous*), and several hundred species of vascular plants, ferns, lichens, liverworts, mosses, and fungi.

In the Far East the numbers of rare and endangered vertebrate species, included in the former Soviet Union Red Data Book, is the highest in comparison with all other regions of the country. There are 25 species of mammals red-listed (94), 39 species of birds (of 80), 4 species of amphibians and reptiles (of 46), 1 fish species (of 4), (Rare Vertebrates of the Soviet Far East and their Protection, 1989[1]). These numbers are indicators of the biodiversity richness of the region, and also the negative influence of anthropogenic activities.

2.3 Primorskiy Kray: Current fauna status

Primorskiy Kray (Primorye) is the richest region in the RFE in term of biodiversity. It hosts 60 mammal species (25%) of a total of 245 found in Russia, and 380 bird species (61%) of a total of 620 in the whole Russia (Ministry of Environmental Protection and Natural Resources of Russian Federation, 1995).

Originally, the whole Kray was covered by coniferous-broadleaved forests with Korean pine/cedar, Ayan fir, silver fir, Daurian larch as the dominant species. However, during the last decades, due to intensive commercial harvesting, a significant part of the primary coniferous-broadleaved forest has been alterated into secondary deciduous forest. Even in the remaining forests, such species as Japanese oak (*Quercus mongolica*), Manchurian walnut (*Juglans manshurica*), Kolomicta vine (*Actinidia kolomicta*), and Amur grape (*Vitis amurensis*), which play

[1] In the book, the Fast East is not including Yakutia

an important role in many animal's lives, have disappeared as a consequence of changes in the forest formations.

Alteration of the ecosystems have resulted in degradation of habitats, and in a dramatic decrease in the numbers and distributions of forest-dependent species. Examples on this development are the Amur tiger, the Amur leopard, the spotted deer, the Amur goral, the red wolf, the Far East forest cat, the Himalayan black bear, and a great number of bird species. According to data from the Federal Department of Hunting and Gaming, the numbers of some rare vertebrate species in 1974 were : spotted deer – 670–700 individuals, Amur goral – 700, Himalayan black bear – 1,500–3,000, Amur leopard – 38–46 individuals (Pikunov *et al.*, 1974).

Some of the species are included in the IUCN Red Data Book: the Red wolf, the Amur leopard, the Amur tiger, the Amur goral, the Scaly-sided Merganser, and others.

Altogether, in the Primorskiy Kray, 20 species of mammals and 82 species of birds were registered as rare and endangered in 1994 (Primorskiy Environmental Protection Committee, 1995).

Intensive industrial development has been the major cause of habitat degradation for a number of hunting species. The most comfortable living areas, such as river valleys, lowlands, foothills are involved in industrial development and by that pushing animals out from their best habitat areas. Many of them, having a low tolerance to new environments, are at high risk.

Economic instability, absence of needed control and high prices of animal products on the black market in China and Korea have promoted a strong increase in poaching. Mainly due to poaching, 160–170 of the famous Amur tigers have been lost between 1990 and the summer of 1994, which reduced the population from over 400 to 250 individuals during four years (Pikunov, 1994). Other valuable animals on the Chinese market are the Himalayan black bear, the Amur leopard, and several species of deer.

2.4 Conclusions

The Russian Far East is characterized by unique complexes of biodiversity. Many plant and animal species are endemic to the bioregion, both within Russia and worldwide. However, rapid industrial development has affected many of these species.

Alteration of ecosystems leads to habitat destruction and fragmentation of forest-dependent species, and therefore decreasing the numbers of populations and the habitat distributions.

Poaching is the second cause for decline of populations in the RFE, especially during the last several years.

3 The System of Protected Area in the Russian Far East

3.1 Introduction

Despite the fact the Far East is the richest region in term of biodiversity, all forms of protected areas occupy only approximately 3% of the total territory (Ministry of Environmental Protection and Natural Resources of Russian Federation, 1994).

Being the part of the united Russian protected area system, the Far East has the same types and forms of protected territories, which are described below. The RFE, however, has no single National Park, but there is a plan to create a number of them in the near future.

The administration and management, by the Federal government, of the Russian protected area system have a lot of problems presently, reflecting the current political and economic situation in Russia.

3.2 Types and forms of protected areas in Russia and their role in the preservation of biological diversity

In the effort of protecting flora and fauna and to conserve significant landscapes and ecosystems, Russia has created various types and forms of protected territories. Much of Russia's biological diversity is preserved in the form of strictly protected scientific reserves – *Zapovedniks*. The National Park system, which is only thirteen years old, is another major component of federally-managed protected areas. *Zakazniks* (special purposes reserves) and Nature Monuments, which can be established on the federal and regional levels, play a more significant role at the regional level, forming the backbone of a regionally-administered protected area network.

By December 1994, Russia had 88 *Zapovedniks*, covering a total area of 29,120,800 ha (1.42% of Russia's territory); 28 national parks, covering 6,443,100 ha (0.38% of Russia's territory); and more than one thousand regional *Zakazniks* and Nature Monuments covering approximately 4% of Russia's territory (World Bank, 1995).

Other than their main function – to preserve biological diversity – Russia's protected area system provides many other important functions, such as educational functions and recreational and aesthetic values.

3.2.1 *Zapovedniks* (Strict Natural Reserves)

The *Zapovedniks* system is unique for Russia, and is regarded as one of the oldest and most effective protected area systems ever established. In the former Soviet Union, the system of *Zapovedniks* comprised the primary and the most important type of protected areas. They fall within category I of the IUCN classification of protected areas, which is the strictest level of protection.

The first *Zapovedniks* – *Barguzinskiy*, near Lake Baikal, and *Kedrovaya Pad'* in the Far East were created in 1916. From the beginning, the *Zapovedniks* were intended to be scientific outdoor laboratories and classrooms for scientists. Thus, human activities within *Zapovedniks* are restricted to science and reserve maintenance. Free from economic activities, they are excellent models for comparison of natural ecosystem processes and functions of areas with human disturbances. Research and monitoring data, collected for decades and accumulated in *Zapovedniks* archives, give important and valuable information.

Zapovedniks comprise the most significant geographical areas in terms of biological diversity: species, their habitats and ecosystem representations. A rather large number of *Zapovedniks* have been established. Many of them are adjacent to, or surrounded by, extensive wilderness areas, which remarkably increase the effectiveness of the conservation of virgin ecosystems. Presently, *Zapovedniks* conserve populations of more than two-thirds of the rare and endangered species listed in the Russian Red Data Book. They preserve: from 400 to 1400 species of higher plants, representing 20–30% to 60–80% of the vascular plant communities within the floristic zones of Russia; 168 species of terrestrial mammals (69% of the terrestrial mammals identified in Russia); 515 species of birds (83% of the birds in Russia); 40 reptile species (61% of reptiles in Russia); and 26 species of amphibians (96% of amphibians in Russia) (World Bank, 1995).

Most of the *Zapovedniks* are managed directly by the Division of Nature Reserve Management, which is part of the Ministry of Environmental Protection and Natural Resources. Four *Zapovedniks* are managed by the Russian Academy of Sciences.

3.2.2 National Parks

The National Park system in Russia is a more recently established protected area system. The first ones *Losiny Ostrov* and *Sochi* were established in 1983. National parks fall under category II of the IUCN classification of protected areas. They are created for the protection of natural ecosystems and cultural heritage. National Parks allow controlled educational, recreational,

scientific and cultural activities. In Russia, it is expected that they will play an important role in development of ecotourism, which is not allowed within *Zapovedniks*.

One of the distinguished features of the Russian National Parks is a focus on protection of representative ecosystems within a bioregion, while National Parks in the United States, for example, mainly protect unique geological features or "beautiful" landscapes (Newell and Wilson, 1996). Rough estimates conclude that up to 800 vascular plant species and more than 200 vertebrates (190 birds and 50 mammals) have been registered in the existing National Parks (World Bank, 1995).

National Parks are established and financed by the Federal government. Currently, the majority of the National Parks (26 of 28) are considered as objects of the Federal Forest Service, but most of them are directly managed by the regional units of the Federal Forest Service.

3.2.3 *Zakazniks*

Zakazniks are a type of protected areas where temporary or permanent limitations exist on some forms of economic activities in order to protect an ecosystem or a particular animal/plant species. Sometimes the restrictions on economic activities are only valid during specific seasons. The *Zakazniks* fall within category IV of IUCN classification system of protected areas.

Zakazniks can be founded by federal or regional governments. There are 69 federal *Zakazniks* currently in Russia, covering a total of 11,500,000 ha, and more than one thousand regional *Zakazniks*, covering about 44,000,000 ha. Some 70% of the *Zakazniks* protect the fauna, 12% are botanical reserves, others are landscape or geological reserves (Newell and Wilson, 1996).

Most of the *Zakazniks* have been organized with the objective to protect the commercial hunting rather than to protect game species. Therefore, more is known about the commercially valuable wildlife than about the biological diversity of these areas. Within the federal *Zakazniks*, 21 rare (which are listed in the Russian Red Data Book) mammals, and 68 rare birds have been registered (World Bank, 1995).

Russian *Zakazniks* are managed and protected by two main bodies, the State Game Inspection, a subdivision of the Department of Hunting and Game Management of the Ministry of Agriculture, and the Federal Forest Service and its regional units.

3.2.4 Natural Monuments

Natural Monuments are designated to protect objects of a special interest, which can be a unique natural or man-made ones. They fall under category III of the IUCN classification. The objectives of Nature Monuments are very similar to those of the *Zakazniks*. However, due to the quite small territories of the Natural Monuments (from 100 m^2 to 500 ha), they can not provide an appropriate level of ecosystem protection.

Natural monuments are managed by local committees of the Ministry of Environmental Protection and Natural Resources.

3.2.5 Other forms of protected areas

Other forms of Russian protected areas, which should be mentioned, are the Territories of Traditional Natural Use, the Nature Parks (*Prirodnye Parki*), the Private Nature Reserves, micro-sanctuaries for insects, wetlands protected under international conventions, Scientific forest reserves, green belts around cities and towns, and many others. Also, "special protected forests" are designated by the Federal Forest Service and they have different types of restrictions and management rules.

Table 1. Extent of *Zapovedniks* and *Zakazniks* in the Far East in the beginning of 1996.

	Zapovedniks	*Zakazniks*
Primorskiy Kray[a]	6	13
Khabarovskiy Kray	4	25
Amur Oblast'	2	22
Sakhalin Oblast'	2	14
Magadan-Chukotka Region	2	7
Kamchatka	2	19
Yakutia	2	20
All	20	120

[a] *Zapovedniks* and *Zakazniks* of Primorskiy Kray are shown in Figure 2.
Source: Newell and Wilson, 1996.

3.3 Numbers and scale of *Zapovedniks* and *Zakazniks* in the RFE

In 1985 the Russian Far East had 16 *Zapovedniks* with a total area of 6,179,951 million ha (Rodger, 1990). At that time, 109 *Zakazniks* existed and represented 30% of the whole territory (Rodger, 1990).

Presently, (in the beginning of 1996), 20 *Zapovedniks* and 120 *Zakazniks* exist in the RFE. The extent of protected areas is shown in Table 1 for each administrative region.

Due to the fact that many of the regional *Zakazniks* exist only "on paper", *Zapovedniks* can be considered as the only protected areas, where biodiversity is conserved more or less sufficiently.

Names and sizes of all *Zapovedniks*, their status, and the area protected in each administrative region of the RFE are presented in Table 2.

3.4 Protected area system: Current status and problems

3.4.1 General assessment

Despite the number and areas of Russian protected territories, many plant and animal species of the country are still outside any considerations of conservation and protection. Moreover, the whole protected area system has numerous problems.

Since Russia is currently in a transition to a market economy, *Zapovedniks*, *Zakazniks*, and other forms of protected areas, can hardly fulfill their major missions, namely to protect the biological diversity of the country, or any other functions, for which they were established.

The main problems affecting the Russian protected area system are the destruction of the centralized administration, lack of coordination and control, lack of united management and planning structure, lack of funding and of public awareness, and bad regional management.

The Division of Nature Reserve Management (within the Ministry for Environmental Protection), which is responsible for policy making, management, finances and staffing of *Zapovedniks* has been destroyed and lost its power. Protected area management is now divided among several agencies, each of which has a number of departments with different functions. The result of this transition is a decreased responsibility for the protected areas.

Budgets for all forms of protected territories have been cut dramatically over the last five years. Most of *Zapovedniks* are currently operating with less than 30% of their original budgets. As a result law enforcement has declined and scientific research is going down.

In comparison with other parts of the world, the huge territory of former Soviet Union has the least protected areas (Table 3). Thus, there is a great need for expansion of the protected territories network. However, the existing mechanisms for designation and creation of such new areas are inadequate and poor.

Table 2. *Zapovedniks* of the Russian Far East in 1996.

Administrative region (area, km^2)	*Zapovedniks*	Area, km^{2a}	Status[a]	Total area under protection (in percentage)
Primorskiy Kray (165.9*1000)	6	6391.14		3.85 3.42 (land)
	Kedrovaya Pad'	178.97	Zapovednik of the RAS[b]	
	Ussuriyskiy	404.32	Zapovednik of the RAS	
	Sikhote-Alin	3499.50 +29.0 (aqu)	Biosphere reserve	
	Lazovskiy	1200.24	Federal Zapovednik	
	Far East Marine	12.2 + 630.20 (aqu)	Zapovednik of the RAS	
	Lake Khanka	379.81 + 56.90 (aqu)	Federal Zapovednik	
Khabarovskiy Kray (824.6*1000)	4	7348.12		0.89
	Bol'shekhekhtsirskiy	451.22	Federal Zapovednik	
	Komsomol'skiy	638.66	Federal Zapovednik	
	Verkhne-Bureinskiy	3584.44	Federal Zapovednik	
	Botchinskiy	2673.80	Federal Zapovednik	
Amur Oblast' (363.7*1000)	2	1972.5		0.54
	Zeyskiy	993.90	Federal Zapovednik	
	Khinganskiy	978.36	Federal Zapovednik	
Sakhalin Oblast' (87.1*1000)	2	1202.59		1.38
	Poronayskiy	566.94	Federal Zapovednik	
	Kuril'skiy	635.65	Federal Zapovednik	
Magadan-Chukotka Region (1.199.3*1000)	2	16794.55		1.40
	Magadanskiy	8838.05	Federal Zapovednik	
	Wrangel Island	7956.50	Federal Zapovednik	
Kamchatka Oblast' (472.3*1000)	2	47476.79		10.05
	Kronotskiy	10990.00	Bioshere reserve	
	Kommandorskiy	36486.79	Federal Zapovednik	
Yakutiya (3.103.2*1000)	2	22801.08		0.73
	Ust'-Lenskiy	14330.00	Federal Zapovednik	
	Olyokminskiy	8471.08	Federal Zapovednik	
The Russian Far East (6.216.1*1000)	20	103957.56		1.67

[a]Sources: Ministry of Environmental Protection and Natural Resources, 1994.
[b]RAS = Russian Academy of Sciences.

Table 3. Worldwide protected areas.[a]

	IUCN categories I-III %	All IUCN categories %
World	3.04	5.17
Russia[b]	1.83[c]	2.08[d]
Asia	1.31	4.26
Europe	0.99	8.00
North and Central America	7.03	10.82
South America	3.35	5.96
Oceania	7.98	9.91
Africa	2.99	4.49

[a]World Conservation Monitoring Center, 1992.
[b]Ministry of Environmental Protection and Nature Conservation of Russian Federation, 1994.
[c]Russian *Zapovedniks* and National Park fall to IUCN categories I-III.
[d]This figure does not include the regional level *Zakazniks*.

Table 4. Examples of disturbances in *Zapovedniks* and sums of fines collected in 1994.

Types of disturbance	Number of disturbances disturbances	Fines	
		Number	Sum (in $)
Illegal forest harvesting	11	11	27
Illegal haying and pasturing	1	1	–
Illegal fishing	144	144	–
Illegal hunting	68	No data	632
Illegal gathering of nuts, berry, mushrooms, etc.	23	23	108
Illegal visits	42	26	11
Illegal fires	13	–	–

Source: Primorskiy Environmental Protection Committee, 1995.

3.4.2 Primorskiy Kray: Main problems and trends in the protected area system

Primorskiy Kray has 6 *Zapovedniks*, 13 *Zakazniks* and 152 Natural Monuments (of which 147 have not been officially approved yet) (Newell and Wilson, 1996). The Primorskiy Kray *Zapovedniks* and *Zakazniks* are shown in the Figure 2.

Notwithstanding the relatively high percentage of strictly protected lands (3.42%, Table 2), the existing protected area system can not guarantee conservation of rare and endangered species of plants and animals of the region even within these areas. This is due to:

1. Borders of many *Zapovedniks* and *Zakazniks* have been made without consideration of the elementary units for conservation.

2. Populations of many rare and endangered plant and animals species have not been included in the protected areas. For instance, the recently established Hankayskiy *Zapovednik* includes only 37,000 ha, leaving two thirds of the populations of major protected species in the region outside the protected territory (Primorskiy Environmental Protection Committee, 1995).

The situation is aggravated by the fact that during the last years the effectiveness of scientific and protective work has decreased dramatically due to lack of funding. Absence of required control and measures of punishment has led to significant increase in a number of different disturbances within protected areas (see Table 4).

For the long term, the Primorskiy Kray Ecological Program (1993) has planned the enlargement of all types protected areas (see Figure 2). However, the developments of nature protection initiatives and exploitation of natural resources in the region have resulted in strong contradiction between each other. For example:

- The planned expansion of the Sikhote-Alin Biosphere reserve to the east contradicts with future industrial development of a silver deposit, discovered in that territory (Primorskiy Environmental Protection Committee, 1995);
- Due to shortage of coal in the region, it was decreed by the Kray Administration to develop the Banevurovskoe coal mine, located near the Ussuri Zapovednik; this development will result in a changed water regime of the Komarovka river (in the territory of the Zapovednik). As a consequence of the changed water regime the river's biota will change, which is the richest of all rivers of the Far East (Primorskiy Environmental Protection Committee, 1995).
- Despite the existing level of protection, on the territories of many *Zakazniks* (for instance, the Taezhny and the Vasil'kovskiy) commercial harvesting is carried out. Both of these *Zakazniks* are under the threat of elimination due to growing requirements of wood in the region.

Thus, the protected area system in the Primorskiy Kray is affected by similar problems, which are characteristic for all of Russia's protected area system. However, due to the large stock of natural resources, the protected territories in the Kray are, perhaps, under a bigger threat.

3.5 Conclusions

The most effective and efficient way of conserving biodiversity may be to protect species in their habitat areas. For this reason, Russia has created a vast network of areas with different degrees of protection. However, the existing system does not match the needs of biodiversity protection. Moreover, the whole system is suffering from lack of centralized management and control, lack of funding, and many other problems.

Growing industrial development of the Far Eastern region, especially the enhancement of wood and minerals extraction, threatens the protected area system, and therefore, the unique biodiversity of the region.

The regional government should pay more attention to conservation measures of the local rich flora and fauna, promote the creation of new protected areas, and maybe develop sustainable long-term ecotourism in the region as a source of money, rather than developing destructive short-term extractions of the natural resources.

To prevent contradictions between industrial development and nature protection initiatives in the region, comprehensive cost–benefit analyses and environmental impact assessments should be performed in each individual case.

4 Assessment of the Russian Forest Exploitation in the Region

4.1 Introduction

Forest covers 45% of the Russian Far East. Different scientists estimate that 25% to 50% of the forest are still undisturbed by harvests (Newell and Wilson, 1996). This figure is much higher than in other industrial countries. Most of the forest is concentrated in Khabarovskiy and Primorskiy Krays.

In Primorye the percentage of forested land of the total land area is 73% with a range of 6%–92% in different subregions of the Kray (Primorskiy Environmental Protection Committee, 1995). In Khabarovskiy Kray the average forest cover is 60% (The Forest Fund USSR, 1990).

Khabarovskiy Kray leads in timber production, having about 40% of the total timber production in the RFE. Primorskiy Kray is the second largest producer. Timber exports constitutes 20–25% of the total timber production, and the export is increasing. Most timber exports are transported to Japan in the form of raw logs (90%) (Newell and Wilson, 1996).

Table 5. Harvest of individual forest species in Primorskiy Kray, in thousands of m^3.

Year	Cedar	Deciduous species
1966	33,000	460
1978	25,000	590
1988	24,000	800

Source: Primorskiy Kray Ecological Program, 1993.

4.2 Forest exploitation in the Russian Far East

4.2.1 Forests and forestry

The forests of the Far East have been subject to exploitation by the Russian timber industry since the beginning of industrial development of the region.

In the last century, old-growth cedar-broadleaved or coniferous forests covered 90% of the Primorskiy Kray (Rosenberg, personal communication). Since that time, heavy logging dramatically reduced the forest stock of native forests to 20–50% of the forested area, depending upon the region. Most of the logging has been concentrated to coniferous species, mainly to the Korean pine/cedar (*Pinus koraiensis*) (Table 5).

At present, cedar forests[2] are occupying 19.6% of the total forest land, and fir and spruce forest 24.2% (Primorskiy Environmental Protection Committee, 1995).

After harvesting, coniferous forests are being replaced by deciduous varieties, with birch and lime as dominant species. The ecological functions of the forests – hydrological role, habitat capacity, etc. – are dramatically changed by this transition (Rosenberg, 1972).

In 1989, logging of Korean pine/cedar (*Pinus koraiensis*) was prohibited. However, it reduced only the reported amount harvested. Illegal logging of cedar increased instead.

Despite a general decline in the timber production in the region over the last few years, exports of coniferous species (in particular Korean pine) have remained relatively constant, exports of oak and ash are increasing (Newell and Wilson, 1996).

4.2.2 Logging technologies

In the Russian Far East the timber industry has used two main technologies: "high-grading" selective cutting (2/3 of the logging carried out), and small-scale clearcutting (1/3) (Newell and Wilson, 1996).

Russian "high-grading" selective harvesting, which is usually practiced, is a method where only the largest and the most commercially valuable species are taken. Such selective logging is withdrawing commercial timber species, and introduces other species characteristic for secondary forests. It also modifies or removes animal habitats and food sources, and thus has a detrimental effects on forest-dwelling animal species.

Only in Primorye, so called "conditional-clear" cutting (or "voluntary-selection") has been introduced and started to be used in the beginning of the 1980s. This method interchanges a band of clearcut area with a band of uncut forest. Despite some negative features, this method gives an opportunity for relatively fast natural regeneration of the forest.

One of the most negative features of the Russian timber industry is the use of heavy outdated logging and transport machinery, and bad road construction.

One of the good features, however, is that according to the Russian forestry laws, logging is prohibited on slopes exceeding 30 degrees, and clearcutting on slopes exceeding 20 degrees.

4.2.3 Reforestation

Natural reforestation is the most practiced method for regeneration in the Russian Far East. Russian scientists consider forest plantations as simple tree farms, which never can reconstruct

[2]Forest is considered as cedar forest if cedar represents 20% of the total growing stock.

a complex, dynamic natural forest. Monocultural forest can not provide ecological niches for varieties of plant and animal species. Therefore, most ecologists prefer logging and regeneration methods that do not require artificial regeneration.

However, artificial reforestation appears to have increased during the last couple of years, due to investments by international timber enterprises, which use large-scale clearcutting followed by artificial reforestation.

4.3 Current threat to the forests in the RFE

Due to both the tremendous stock of natural forests and the economic-geographical position of the region, the Russian Far East has attracted a lot of multinational forest companies since the eastern borders were opened in 1990. These companies are investing a substantial amount of money in joint timber enterprises.

Most of the multinational timber corporations use the large-scale clearcutting technology for extraction of the timber. It causes strong soil erosion, clogging of river systems and reduces the rich topsoil necessary for forest regrowth.

In the conditions of an unstable economy, the Russian government see these joint enterprises as a fast source for money and pay limited attention to the degradation of the environment. With the new western technology, coupled with a worldwide demand for logs, the Russian timber industry is able to clearcut large swaths of forest. Furthermore, this technology allows logging on areas that were inaccessible before.

4.4 Conclusions

The Far Eastern coniferous-broadleaved forest has been subject to harvesting by the Russian timber industry and has been impacted severally, especially during the last 40 years. Korean pine/cedar is a species, which has been strongly extracted. The primary coniferous-broadleaved forest has been replaced by secondary broadleaved forests in most parts of the territory, decreasing the ecological functions of the forests.

Russian forest enterprises have used "high-grading" and "conditional-clearcut" technologies for the timber harvest. It has led to detrimentation of forest genetic diversity, and destruction and fragmentation of animal habitat areas.

However, the old Russian practices can not be compared with the ecological devastation now being carried out by the methods employing large-scale clearcutting technologies in order to obtain inexpensive, high quality timber.

5 Assessment of Major International Investments in the Forest Industry in the Russian Far East

5.1 Introduction

The Russian Far East, especially the Primorskiy Kray (also called the Maritime Territory), thanks to its geographical location and rich natural resources, is today one of the most dynamic and promising areas for the changing Russian economy. Originally, the region was viewed as a military outpost which protected Russia's border to the East. Nowadays it is the eastern gate opening for international cooperation, and the latest member of the Pacific Rim community. International long-term programs of economic reforms are considered to make the Maritime Territory a leader in the economic transition of the entire Asia-Pacific Region.

Yevgeny Nazratenko, Governor of Primorskiy Kray, said:

> "Our territory, as a large transport hub which handles and services one-third of all Russia's exports, is very attractive. The Maritime Territory boasts a unique combination of mineral wealth, including fuel and energy resources. The marine and

> inland biological potential offers another attractive investment opportunity .... In the past 18 months, the turnover of companies with foreign investments has increased 10-fold on the Russian domestic market. We have been working on a program to establish a special custom regime in the Far East, in order to create an attractive environment for foreign investors."[Nazratenko, 1996]

One of the major interests of the foreign investors has been the development of forest enterprises.

5.2 Two Memoranda

The Gore-Chernomyrdin Commission has been praised for promoting US–Russian cooperation as well as a transition to democracy and a free market in the Russian Federation. It developed a Memorandum of Understanding (MOU) for environmental protection that supports initiatives led by the Environmental Protection Agency, US Fish and Wildlife Service, and other governmental agencies for the promotion of the environment and for the protection of biodiversity.

At the same time Ron Brown, former US Secretary of Commerce, and Russian Minister of Foreign Economic Relations Oleg Davydov signed a "Wood, Pulp, and Paper Memorandum of Understanding". This MOU is being implemented on the Russian side by Miron Tatzur, Director of the firm Roslesprom – the State Russian Timber Industry Company (Pacific Environment & Resources Center, 1995).

> "Despite Vice-President Gore's commitment to global environment, the wood, pulp and paper MOU could undermine all the forest protection initiatives underway in Siberia and the Russian Far East. Lacking strict, clear environmental guidelines and controls, the wood, pulp and paper MOU is likely to promote uncontrolled US investment into the corrupt Russian timber industry and give green light to activities which cause great harm to forests,"

said David Gordon, director of the Siberia Forest Protection Project in The Pacific Environment and Resources Center.

5.3 Major international investments in the timber industry[3]

5.3.1 Hyundai Logging Joint Venture

Hyundai Corporation (South Korea) and two Primorskiy regional timber enterprises (Primorlesprom and Terneyles) signed a 30-year agreement with the Primorskiy Krai government in 1991. The joint venture is logging approximately 200,000 m^3 per year near Svetlaya and sells the round wood, mainly to Japan (Figure 3). The corporation is using large-scale clearcutting. Despite protests by the local people (Udege local community) and environmentalists the Hyundai continues to try to gain access to the old-growth forest in the Upper Bikin river basin, a Territory of Traditional Natural Use and Center of Biodiversity (Figure 3).

5.3.2 Trade and Development Agency (TDA, US)

TDA provides grants for US firms to carry out feasibility studies, other planning services needed to promote future funding of major projects. TDA granted the Global Forestry Management Group (GFMG) $500,000 to conduct a feasibility study of logging in Khabarovsk Region.

[3]Sources of information for this chapter are: *A Special Report: US Government Financing in Siberia and the Russian Far East and its Effects on Biodiversity and Forest Protection*, prepared by The Siberia Forests Protection Project, Pacific Environment and Resources Center, Sausalito, CA, USA, October 1995; and Newell, J., and Wilson, E., 1996, *The Russian Far East: Forest, Biodiversity Hotspots, and Industrial Development*, Friends of the Earth-Japan.

One of the areas of focus of this study is the Khor river watershed, an area of high biodiversity with a significant part of the remaining Siberia tiger habitats in the RFE, as well as lands claimed traditionally to be managed by the Udege people (Figure 3).

GFMG's potential logging activities in the region threaten 3 million acres of roadless, old-growth forest in the Khor, Sukpai, Samarga and Nel'ma river watersheds in the southern Khabarovsk Region. Although the plans deriving from this feasibility study will directly impact and conflict with other US government-sponsored biodiversity protection initiatives in the Khor river watershed, no consultation between TDA, USAID, EPA, and Fish and Wildlife Service has occurred (see also Section 5.5.3).

5.3.3 Export-Import Bank (US)

At the moment the Bank is heavily involved in the implementation of the Gore-Chernomyrdin Wood, Pulp and Paper Memorandum of Understanding. Yet the Export-Import Bank is developing its own MOU with the Russian timber industry to promote a broad range of forestry sector equipment exports from the US to Russia.

It is supposed to include large shipments of chain saws and heavy logging equipments, which will allow clearcutting in environmentally sensitive and previously inaccessible areas.

5.3.4 Overseas Private Investment Corporation (OPIC, US)

OPIC is a rather unknown US agency that provides political risk insurance, investment grants, and loans to US ventures working abroad. Now OPIC is considering financing several logging and mining ventures in Siberia and the RFE. OPIC supports the Global Forestry Management Group in their efforts to log up to one million acres of virgin fir and spruce forest in the hills around Vysokogornoye in Khabarovskiy Region.

OPIC is also financing a logging venture by the Pioneer Group along the Siziman Bay coast of the Russian Far East. This funding is being carried out without clear environmental guidelines, public disclosure, or public participation. OPIC allows large-scale clearcutting (up to 40 acres in size) in the logging ventures.

5.3.5 Enterprise Funds (US)

Enterprise Funds are US government-sponsored enterprise funds which potentially finance a number of large-scale resource extraction projects. Three of these enterprise funds are of special concern for environmentalists:

- The Fund for Large Enterprises in Russia (FLER), also cosponsored by USAID and OPIC, is aiming at investing up to $20 million per enterprise.
- The Russian-American Enterprise Fund (RAEF) hope to invest $40 million in local timber enterprises and joint US-Russian logging ventures.
- The Defense Enterprise Fund recently invested $1 million of US taxpayer money on a environmentally controversial venture called the Russian-American Ionized Energy Service (RAIES). RAIES is constructing 11 plants in the FE for radiation of round wood in order to protect the wood from dangerous pests and pathogens at export to the United States.

5.3.6 Japanese investments

Japan is the largest importer of the RFE timber since the 1960s. In the middle of the 1970s, Japan was importing almost 9 million m^3 of timber per year and almost all in the form of raw logs. The main imported species are Korean pine, spruce, white pine, and larch. The three KS Sangyo projects have sent more than 40 million m^3 of timber to Japan in exchange for logging equipment and machinery.

In July 1994, the Japanese-Russian Economic Committee identified the priorities for large-scale projects with a total price tag of US $2 billion.

5.3.7 Joint ventures in Khabarovskiy Kray

Four prominent joint ventures operate presently in Khabarovskiy Kray:

1. Sharma Holding/Pioneer Group (US);
2. Interprom (Russia-France);
3. Forest Vanino-Forest Finance (Russia-Norway);
4. Exsprales/ Global Forestry Management Group (Russia-US).

5.4 Large-scale development of ports, roads, and rail infrastructure

To increase exports out of Russia the expansion of ports, roads, and rail are needed. The European Bank of Reconstruction and Development is focusing on the energy and transport sectors of Russia.

5.4.1 Development of the Nel'ma–Sukpai Logging Road

A major danger to Sikhote-Alin's rich forests is the proposed logging road from the town Sukpai to the port Nel'ma on the eastern coast of Khabarovskiy Kray (Figure 3). The road will open up a million hectares of roadless wilderness, and fir, spruce and larch forests in the Samarga and the Sukpai river basins, which are the traditional hunting grounds of the Samarga Udege and the northern habitat of the Amur tiger.

5.4.2 Development of specialized coastal ports

Ol'ga, Plastun, Svetlaya, and Amgu are four ports along the Primorskiy coast that have become major export centers for forest and marine resources (Figure 3). These cities are timber towns; it is much easier for timber companies to "control" the ports here than at the larger ports of Nakhodka, Vostochny and Vladivostok.

Timber exporters have been working to convert former military ports to civil ports at Bol'shoy Kamen' and Sovetskaya Gavan' in Khabarovskiy Kray.

5.5 Biodiversity conservation programs

5.5.1 Environmental Policy and Technology Project (USAID)

US Agency for International Development is supporting several initiatives to protect biodiversity and promote sustainable development of Siberia and the Russian Far East.

The biggest project is a $16 million *Environmental Policy and Technology Project*, promoting sustainable natural resource management in the RFE. The project includes components of legal and institutional reforms, forest restoration, and biodiversity conservation. The initiatives provide support to existing protected areas, and help to design new protected territories. Major interest of the program is concentrated on the rich area of the Sikhote-Alin Mountain Range.

5.5.2 US Forest Service

The US Forest Service currently has several ongoing relationships with the Russian Forest Service agencies in Siberia and the RFE. The International Forestry Department of the USFS has established a sister relationship between the Chugash National Forest in Alaska and the Magadan

Nature Reserve, and supports programs on environmental education, ecotourism, reforestation, and new technologies.

In Khabarovskiy Kray, USFS is helping to promote reforestation, and to improve forest protection.

5.5.3 Khor river watershed

The Khor river watershed has been the site of several initiatives in order to map, study, and conserve unique biodiversity of this region of the RFE. The Wildlife Foundation, an environmental organization of the city of Khabarovsk, has been mapping the lower part of the watershed to create a network of protected territories. This network would provide a landscape level protection for rare plants and animals in the watershed. In the plans of this group is also as large, 750,000-acre wildlife refuge to protect a vital north-south corridor for the Amur tiger. The Wildlife Foundation has worked with the Hornocker Wildlife Institute (Idaho, USA), and is supported by WWF and USAID.

5.6 Conclusions

By looking for a quick source of money, Russia has opened large rich territories for international exploitation. The Russian Far East, due to its tremendous stock of forest resources has attracted attention from international forest corporations. These corporations invest a huge amount of money for development of joint forest enterprises with the objective to extract and to export the wood, mainly in form of raw logs. Many of these activities have not performed any assessments of the impact on the local environment.

Many of the timber companies are sponsored by US governmental funds, and the company activities are creating a conflict with biodiversity programs, which are also funded by US governmental agencies and are assigned to the same areas.

Thus, the forests of the RFE are threatened by large-scale logging, as central and regional governments are trying to find short-term solutions to their severe economic problems. This creates a serious threat to the unique biodiversity of the region.

6 Analysis of Forest-Dwelling Endangered Species of Vertebrates

6.1 Introduction

Deforestation, logging and other human impacts on the forests threaten especially those species which are strictly dependent on specific types of ecosystems. Deforestation destroys habitats or changes the habitats to a more extreme environment that many of the species can not tolerate. Further, deforestation generally reduces the number of species, the genetic diversity of individual species and the variety of ecosystems.

Geographical distribution of many vertebrate species in the Russian Far East are strongly associated with the Far Eastern cedar-broadleaved forests. The Amur tiger, the Amur leopard, the Far East Cat, the Himalayan black bear, many species of birds belong to such species. Reduction of the areas of cedar-broadleaved forests has led to contraction of species distributions and population sizes.

Two big wild cats – the Amur tiger and the Amur leopard – living only in Russia, are not only a property of the country. To save these animals is an obligation of international importance. Other species, currently attracting less attention, are as important.

Under the threat of a rapid industrial development in the Russian Far East (mainly the industrial forest sector), there is a need to make estimates on the future of the species, and to propose additional measures for their protection. A detailed analysis of the past and present species status has been carried out in order to support these recommendations.

6.2 The Amur/Siberian Tiger (*Panthera tigris altaica*)

6.2.1 General information

The *Panthera tigris altaica* is one of five remaining tiger subspecies (three subspecies have become extinct during this century). It is the world's largest cat and the only tiger subspecies that inhabits temperate forests.

All tigers (*Panthera tigris*) are in the IUCN Endangered Red List; of these the Amur tiger (Siberian), the Southern Chinese, and the Sumatran subspecies are listed as Critically Endangered (Current Feline Species at EFBC/FCC, 1995).

The Amur tiger ranges are located in the Russian Far East, and to some extent in Korea and China. The animal habitats are in coniferous and hardwood forest, better known as "taiga".

In Russia the Amur tiger is a symbol of the Ussuriland forest in the Sikhote-Alin mountain range, and is a top predator in the Amur ecosystems. However, only 200–250 tigers are estimated to be left in the habitat of the southern part of the RFE. These remaining Amur tigers are under threat as a result of poaching and habitat destruction.

6.2.2 Historical trends of distribution and population size

Dynamics of the size of the tiger population and its relation to the habitat area is complicated and irregular, and can be divided into several stages:

1) In the 19th century the species was widely distributed in the territories of Amursky, Chabarovsky and Primorskiy regions as well as in northeastern China and in the Korean Peninsula (Figure 4). It was also possible to see the tiger even in southwestern Siberia close to Lake Baikal. During the last decades of 19th century and the beginning of 20th century a trend towards a decrease in the population size, caused by man, occurred. However, the population still retained at the average level of ecological capacity of the habitat. The northern habitat border was defined by the latitude 50-51° North, on the left side of the Amur river basin. The animals were not only living in the mountain forests but also in the Ussuri and the Amur river valleys and in lowlands as well. The population of tigers on the Russian territory was estimated to be more than one thousand individuals (Pikunov, 1996).

2) In the beginning of the 20th century the Amur tiger was a commonly hunted species, and up to a hundred tiger skins were delivered to market places every year. Between early 1900s and the late 1930s the population started to decrease catastrophically both due to hunting and intensified industrial logging and agriculture. These activities resulted in a habitat fragmentation. The animals disappeared from the lowlands, including the area around Lake Chanka, from valleys of big rivers (the Amur and the Ussuri), along the railway Chabarovsk-Vladivostok, and from the city surroundings. During the 1930s the tiger remained only in the almost impassable isolated regions of Sikhote-Alin and Eastern-Manchurian mountains, in Small Hingan, and on the western side of the Amur river basin.

A census of the tiger population conducted by L.G. Kaplanov in the late 1930s revealed that only 20–30 tigers inhabited the Russian territory. There was a real threat of tiger extinction from the Russian Far East (Pikunov, 1996) at that time.

3) In 1947 Russia imposed a ban on tiger hunting. Approximately at the same time the tiger hunting was prohibited in China and North Korea. Through efforts by Russian scientists, in particular by K.G. Abramov, catching tiger cubs was forbidden in 1955. Some years later it was allowed again, but severally restricted in the form of licenses. At this time the population stopped to decrease, stabilized, and started to grow step by step. The habitat area was increasing again. Results of 1958–1959 census indicated the presence of 55–56 tigers in Primorye (Abramov, 1961a), and 90–100 individuals in Primorskiy and Chabarovsky Krays (Pikunov, 1996).

4) From the middle of the 1960s until the middle of the 1980s the tiger population increased in size and distribution. The animals had expanded very well to the south of the Amur river; and the habitat integrity in Sikhote-Alin region had been restored. The habitat in East-Manchurian

Mountains became more stable. However, at the same time tigers disappeared from the isolated area in Small Hingan.

According to the literature, in 1965 about 70 tigers inhabited in Primorye (Kudzin, 1966) and 120 totally in the Far East (Sludsky, 1966). A census in 1970 conducted by A.G. Yudakov and I.G. Nikolaev revealed 129–131 individuals in Primorye. A census in 1977–1979 headed by V.K. Abramov concluded 170–190 tigers (Pikunov, 1996).

At this time timber enterprises increased logging in the broadleaved cedar forests, the main tiger habitation. The major interest of the timber enterprises was the cedar/Korean pine (*Pinus koraiensis*) forests. Purchases of ungulate meat also increased at the same time. An increase in the number of tigers and a simultaneous decrease in the amount of suitable habitat available resulted in the dispersal of immature tigers into territories cultivated by man. As a result, confrontations between man and tiger increased, which usually led to the death of the tiger.

In the 1980s the remaining cedar forests were cut very intensively, and the logging was also expended to oak forests. Several snowy winters had diminished the boar and deer populations dramatically and forced the tiger to seek food around the settlements. The hungry tigers came even as far as to Vladivostok and they were killed immediately. At this point in time the tiger population stopped growing.

5) The next census was organized by D.G. Pikunov and A.P. Bragin during 1984–1985. They counted 200–210 tigers in Primorskiy Kray and 240–250 in total for the Russian Far East.[4] Most of the tiger population was located in the North and partly in the Central parts of the region, due to less destruction of the habitats (Figure 5).

This census revealed a basis for proposals of conservation needs, which appeared to be necessary for prevention of further degradation of the tiger's environment. The program suggested a creation of two large protected territories: the Northern territory (the central part of Pozharsky region, the basin of the Bikin river, the eastern part of Krasnoarmeysky region, basin of the upper tributary of Big Ussurka river, the north-eastern part of Dalnegorsky region, and part of the Terneysky region close to the Maksimovka river basin in the west) with a total area of 33,250 km^2, and the Southern territory (Lazovsky and Olginsky regions, with adjoining parts of Partizanskiy and Kavalerovsky regions) with an area of 13,500 km^2. The recommendations aimed to stop all types of forest exploitation in the territories, and to ban the ungulate hunting for several years. These recommendations were presented to the Primorye Kray Administration, and to the Russian Department of Hunting and Game, which were responsible for the protection of rare species of the fauna. However, the organization and the establishment of new protected areas in Russia were very difficult from a legal point of view and due to conflict of interest. The proposed areas were also an arena for timber harvesting and hunting. Therefore, the only result of the above-mentioned and proposed measures was a prohibition of hunting of wild boar during two hunting periods.

6) Since 1990 Russia has gone through political and economic reforms. The Russian eastern borders were opened, and the Far East became available to foreigners. Not only tiger skin but bones and other parts of the tiger's body used in Tibet medicine became very valuable and marketable products. From 1991 to 1993, 50–60 (some estimates say 70) tigers were killed annually in Primorye and brought to China and Korea. This poaching together with the deaths caused by natural processes destroyed the reproductive capability of the tiger population.

In March 1993 an international working group was organized with the objective to save the Siberian tiger, and in June 1994 the "Siberian Tiger Project" was established. According to the recommendations by this group a tiger census was carried out during February–March of 1996 with financial help from the EPT (USAID) project. The census results are not yet available.

[4]There are other literature sources indicating a presence of 400–500 tigers in 1985 (Hornocker Wildlife Institute, 1995).

6.2.3 Current situation and the future trend

Taking into account the development presented during the last 100 years, the following conclusions can be made:

- The total tiger habitat area of the Russian Far East has been decreased by one third, the population size consists of 200–250 individuals (15–20% of the population 100 years ago). Some tigers may habitat the Heilongjiang and the Jilin Provinces in northeastern China, however an expedition led by Russian scientists recently did not find any tiger tracks there (Korkishko *et al.*, 1995).
- The habitat area on the western side of the Amur river (including Small Hingan) has disappeared forever. No animals have been seen in the northwestern (in Zabaikalye) or in the northern (southern part of Yakutia) parts of the region.
- The tiger has left the lowland territories and the valleys of big rivers, which were altered by intensive logging and agriculture.
- At the present, the tiger populations in the RFE remain only in the Sikhote-Alin and the East-Manchurian Mountains, and they are almost completely isolated from each other. The latter population is really small and occupies too small territory in order to have a stable development unless urgent measures are taken. Each of the tiger ranges is, in turn, separated by elements of anthropogenic landscapes and isolate the tigers into micropopulations.
- The inaccessible tiger habitat in the Sikhote-Alin mountains is the main hope for the saving and restoring of the species for the future. This tiger home range is the basic area for the tiger protection projects.

Thus, it must be remembered that the distribution of the Amur tiger has shrunk enormously from its original distribution 100 years ago, and it must be assumed that unless serious measures are taken, the decrease will continue.

6.2.4 Main causes of the tiger disappearance

The main causes of the decline in the tiger population are poaching; habitat destruction and habitat fragmentation; and the detriment of food resources. The poaching can very quickly be regulated by efficient legislation. The habitat destruction and fragmentation, in turn, are long-term threats leading to deep rearrangements in the population dynamics, which finally may result in species extinction. Maintenance of a certain level of prey is also a very important condition for the tigers survival. The decline of food resources that has occurred during the last decades, is another reason for the decreased tiger population.

Poaching

Poaching was the main cause for the tiger decline during 1991–1994. Between 1920 and the beginning of the 1970s, 130 tigers were captured (Yudakov, 1973). In contrast, over 160 tigers were killed between 1990 and the summer of 1994. These three years have resulted in a decrease by 25% of the tiger population in Primorye and by 33% in the Khabarovkiy Kray. On the Chinese and Korean black markets the skin of a tiger costs $15,000 to $20,000, and for tiger bones to be used as in Tibetan medicine the price-tag is $35,000 (Pikunov, 1994).

The WWF Amur Tiger Conservation Project is directed to promote tiger conservation by providing immediate funds for the funding of anti-poaching actions, organizing anti-poaching brigades, and for providing vehicles and other equipments. The WWF reports claim that the presence of the brigades has had a significant effect and the poaching has decreased since 1994 (Pikunov, 1994).

Habitat destruction and fragmentation.

Habitat destruction and fragmentation is probably the primary long-term threat to the survival of the Amur tiger. To support this conclusion a graphic of the tiger population dynamics has been constructed (Figure 6). One curve represents the observed dynamics of the tiger population since 1890 until today. The second curve represents the theoretically calculated tiger population number, assuming that there are no habitat destruction (the calculations are described in Appendix 1). Based on Figure 6, it can be assumed that the population would have restored more rapidly after the ban on hunting was implemented if there had been no habitat destructions.

The habitat destruction and fragmentation have occurred simultaneously with the industrial exploitation of the region, mainly due to the development of the forest exploitation (Nikolaev, personal communication). Fire is a second major reason for causing the elimination of the native forests. Others are the establishment of road systems, and agriculture developments in lowlands and in river valleys.

Initially the tiger was an inhabitant of the Amur and Primorye broadleaved-coniferous forest ecosystems, but the tiger now inhabits the secondary broadleaved forests, which have been created by man-made activities.

(a) Relationship between the tiger and logging and forest management practices. Logging is not always bad for the tiger. Selective cutting, as it was practiced in many regions of the RFE in previous times, created small open sites, where young vegetation produced food for elk and deer. The cedar and ash-tree selective cutting by which a remarkable part of the stands are saved did not affect the tiger habitat significantly. This practice maintained the forest cover, and very often kept high closure of the crowns. Wild boar populations were quite stable, elk and deer populations were even increasing (Yudakov add Nikolaev, 1987).

However, big clearcuts are dramatic for elk, wild boar, the tiger, and other vertebrate species. According to ecologists, tigers generally avoid unforested areas, fields, or open ground. The tiger habitat is generally forested (Miquelle, 1995). While it is clear that clearcuts are incompatible with the tiger habitat, it is difficult to determine the exact percentage of forest cover, which is required by the tiger. According to some scientists the threshold for the forest cover percentage, beyond which the tiger habitation is not possible, is approximately 50%. The tiger can, in some cases, keep quite high population density even in secondary broadleaved forests altered by man-made activities (Nikolaev, 1996). One of the radio-collared tigers being studied by the Siberian Tiger Project near Terney lives in a region where approximately 20% of her home range is in farmland, or other open areas. Although this does not seem to affect her behavior, she has the largest home range of all females studied, and she has killed livestock every year. It is likely that when the percentage of forest cover is less than 60%, interaction between the tiger and people becomes inevitable.

Thus, areas being managed for the tigers in the Russian Far East should be covered with forests by 60% (Miquelle, 1995).

The increase of the tiger population which took place during the period 1960–1980 followed an increased industrial forest exploitation. However, it should be kept in mind, that the man-made activities during this period did not change the habitats drastically, or at least the alterations did not reach a critical threshold. Today, the habitat destruction is much more severe and in some areas the critical point is passed.

Besides the development of special conservation needs and the creation of a protected area system, it is very important for the Amur tiger survival to regulate all large-scale clearcuts in Primorye and southern Khabarovskiy Kray, and to force the local timber enterprises to use selective harvesting methods.

The forest management should aim to increase the extent of old-growth Korean pine forests, which provide important habitat for wild boar as well for many other animal species, which in

turn are food sources for the tiger. Large stands of Korean pine may be created by linking small stands through a proper reforestation. Both legal and illegal harvest of Korean pine must be stopped (although harvest of the cedar has been outlawed, this species is still being harvested and exported).

(b) Influences of roads. The development of road systems (these are usually created for logging purposes) has a critical impact on the tigers. The roads, once constructed, provides easy access not only for loggers, but for many other activities. It is evident that roads increase both legal and illegal activities, which decrease the density of animals substantially. Poachers have more opportunities to shoot tigers and their prey. Forest roads are the favorable paths of the tiger-males. Up to 80% of the route length of the males correlate with roads, and they prefer heavy trafficked roads to silent and old ones (Yudakov, 1987). Most of tigers are killed at road side by poachers at night just from cars.

Thus, restrictions on the access to roads, as well as prohibition of the creation of new roads in the tiger habitat should be key issues in a conservation management plan.

Detrimentation of the tiger food resources

The tiger is a hunter of ungulates. The ungulates can not be substituted from the tiger diet by other prey as it is possible for other carnivores. Thus, if there is a shortage of wild boar, elk and deer, the tiger has to come close to settlements and chase cattle and dogs.

The main prey of the Amur tiger is wild boar (*Sus scrofa ussuricus*). The basic biome for the boar is the cedar forests. Elk (*Cervus elaphus*) has the second place in the tiger diet. The tiger is catching the elk mainly in river basins. The tiger's hunting success of wild boar is much higher (54.5%) than of elk (28.9%) (Yudakov and Nikolaev, 1987).

The distribution and population density of wild boar in the RFE completely depends on the abundance of their main food – the cedar and oak fruits. Therefore, the extent of this animal is tightly correlated with the existing cedar-broadleaved forests. Territorial logging and frequent fires have altered the boar natural habitats dramatically, and redistributed and decreased the population density. The population has moved to inaccessible mountain places where there is still enough food. During the last century the boar populations have decreased substantially (Bromley, 1964), and this development continues. The Korean pine is now saved in the mixed-broadleaved forests. However, the illegal harvest of this species is taking place in the rare remaining forests of the Sikhote-Alin mountains. All the forests at the sea coast from the Samarga river down to Vladivostok with a 20 km width has been cut and burned, and there are no cedar seedlings. The same picture exists in large territories of the Ussuri river watershed, and around other big and small rivers. The situation with respect to cedar forests in the Khabarovskiy Kray is even worse. The oak forests have been changed as well, both by fire and by logging. The destruction of the habitats and the intensive hunting have decreased the boar populations during the last decades by more than 50% (Pikunov and Korkishko, 1992).

It has been shown that on the glades, the density of elk and roe deer populations have increased due to the fact that young trees play an important role as fodder for these species. However, in the next stage a spatial redistribution of the ungulates occurs. This leads to changes of the habitat structure and alteration of the primary vegetative communities. The level of such changes depends on the types of forest harvest (Rybachuk, 1971).

According to zoologists, the adult tiger requires about 50 ungulates per year for survival (Pikunov, 1996), and for a satisfactory existence of the tiger the ratio tiger:ungulates should not be less than 1:500 (Nikolaev, personal communication).

Thus, management programs for the tiger conservation should be designed to provide proper habitats for the wild boar and elk, and reduce the hunting level of these species in order to insure adequate densities of ungulates for the tiger.

6.2.5 Conservation measures, existing and future protection needs

Existing protected area concerning the Amur tiger

Presently, two *Zapovedniks* – the Sikhote-Alin (347 km^2) and the Lazovsky (120 km^2) in the RFE – are concerned with the tiger. However, the areas of the reserves are too small and too isolated from each other to support viable populations of large vertebrates, like the tiger, or to conserve them adequately for a longer period of time.

The Sikhote-Alin Biosphere Reserve, located along the central coast of the Sikhote-Alin Mountain range, is the largest natural reserve. The Amur tigers found in this reserve are part of the biggest population which inhabits both the reserve and the surrounding wilderness, of which most is undisturbed by logging and mining.

Based on 3-years' radio-tracking research in the Sikhote-Alin biosphere reserve, it has been shown that the average home range size of an adult female[5] is approximately 450 km^2 (Miquelle, 1995). This estimation was done by an international group of scientists studying 5 adult females on the territory of the Sikhote-Alin biosphere reserve, the best remaining habitat for the Amur tiger. Therefore, taking into consideration the heavy exploitation of prey species and the poaching of the tiger outside the reserves, this area seems to be a realistic estimate of the home range size of an adult female in a high quality habitat, but may be an underestimate for much of the existing tiger habitat. Additionally, the female tigers are territorial (Yudakov, 1983). Thus, 450 km^2 of the habitat can maintain only one adult breeding female tiger (2.2 adult breeding female tigers per 100,000 ha). These elements are very important and form the basis of a Habitat Protection Plan developed by Hornocker Wildlife Institute and the Sikhote-Alin reserve (Miquelle, 1995).

For a small population of endangered species geneticists have developed two main rules: (1) to save the genetic integrity of a species over a shorter period of time (50 years), a minimum population of 50 adult breeding females is required; and (2) for long-term survival of a population, at least 300 females are required (Suley, 1983).

Presently, there is not a protected area big enough to support 50 adult tigers (22,500 km^2 of high quality tiger habitat is required). Only about 150,000 km^2 of the tiger habitat remains in Khabarovskiy and Primorskiy Kray altogether. If this entire region was a high quality habitat, it would support approximately 330 adult females. However, much of this area is of relatively low quality. Therefore, no further habitat loss can be allowed because it will severely reduce the chances of long-term survival of the endangered population.

The strengthening and expansion of the existing reserves, and the creation of an integrated protected area system, with broad natural corridors, are the first vitally important steps in a tiger conservation plan. The Sikhote-Alin Biosphere and Lazovsky *Zapovedniks* could serve as cornerstones in the development of a regional protection system.

The Russian Federal Government Statement concerning the Amur tiger

In October 1995 Russian Prime Minister Victor Chernomyrdin signed the Statement "Conservation of the Amur Tiger and Other Endangered Animal and Plant Species on the territories of Primorskiy and Khabarovskiy Kray". According to the Statement a National Strategy and a Conservation Action Plan for the Amur tiger conservation will be developed in Russia. Developed by scientists of the Russian Academy of Science, the Russian Academy of Agriculture, the Culture and Economics Foundation, and the international scientific community, it will include different short- and long-term protective measures, strategic priorities, and an action plan for the tiger conservation, which will involve many components. Examples of these compo-

[5] As adult females are critical component of a population (because variation in female reproductive parameters often are the key factor affecting the reproductive rate of a population, and pregnant females of those rearing with youngs (are often faced with the most narrow ecological constrains and habitat requirements), all conservation measures are usually oriented to the needs of females.

nents are anti-poaching, ungulate management, enforcement of CITIES regulations, research, environmental education, and habitat protection.

International projects dealing with the tiger protection

The Siberian Tiger Project protection (STP). The critical situation with the Amur tiger has attracted attention by international organizations. In 1991, the Siberian Tiger Project, conducted by the Hornocker Wildlife Institute began to operate as a cooperative effort between top Russian and American scientists, wildlife biologists and veterinarians. Over the last 5 years the project has collected detailed scientific information on the tiger ecology using radiotelemetry, capture and release programs. A full-scale study was initiated in January 1992 in the Sikhote-Alin Biosphere State Reserve. In 1994 they expanded the project to the territory of the Kedrovaya Pad Reserve. In the beginning of 1995 the Project started compiling scientific information collected so far. This has formed a basis for a comprehensive management plan for the conservation of the Siberian Tiger. The Plan focuses on three main areas: conservation education, conservation and protection of the tiger itself, and land-use planning (personal communication).

The Environmental Policy and Technology (EPT) Project. In September 1994, the Environmental Policy and Technology Project, funded by the United States Agency for International Development (USAID), started to carry out the Russian Far East Sustainable Natural Resources Management Project. The main goals of the project are to promote environmentally sustainable forest management in Khabarovskiy and Primorskiy territories and to enhance the protection of endangered species and critical habitats in the Sikhote-Alin Mountain Region.

With respect to the Amur tiger, the project supports the expansion of the Sikhote-Alin Biosphere State Reserve, a creation of a system of new protected areas, which is necessary for the conservation of the tiger adequately in the long term. Potentially it will also include the creation of the Kema-Amgu National Park, on the northern side of the Sikhote-Alin Reserve. The Tiger Forest *Zakaznik* is a buffer and protected zone along the southern border of the Lazovsky State Reserve (the project is also going to provide infrastructural needs for the *Zakaznik*). Other targets are the Upper Ussuri National Park, located on the northern side of the Lazovsky Reserve, and an ecological corridor in the Chuguevsky Raion, which should serve as a critical link between the two protected areas being developed (Sikhote-Alin and Lazovsky complexes). The Project is also trying to achieve a special protective status for areas in the Khor river basin (personal communication).

Recommended protected areas: A Habitat Protection Plan for the Amur Tiger Conservation

Based on intensive research during the last few years (the STP), the scientists of the Hornocker Wildlife Institute (HWI) have developed a Habitat Protection Plan for the Amur Tiger Conservation in the form of a proposal outlining habitat protection measures (Miquelle, 1995). The HWI has already an extensive experience in developing conservation plans for other large carnivores. The detailed comprehensive plan they developed will help the Russian Government to work out a framework for conservation of the Amur tiger. The main goal of the plan is to protect all existing tiger habitats and to prevent further habitat losses.

According to the plan, there must be a core area that consists of a network of protected areas (Figure 7). This core area will include already existing protected areas (*Zapovedniks* and *Zakazniks*), and proposed new protected areas and ecological corridors (Figure 7). The core area should insure that the tiger metapopulation will not be fragmented and support a minimum population.

All areas important for the tiger conservation must be identified and included in a zone that must be maintained to retain the quality of the existing habitats. Adequate management

should be carried out on all potential tiger habitats outside the core area to insure survival of the entire population. The zoning should set priorities for each area depending on the level of importance. Thus, different sections of the core area will have different level of protection priorities (*Zapovedniks*, National parks, *Zakazniks*, ecological corridors).

All important tiger habitats must be interconnected. Ecological corridors are essential in order to avoid fragmentation of the tiger population, and insure the possibility of genetic exchange. Corridors for the tigers should be wide enough to sustain prey populations and the tigers while traveling.

The scientists have developed a map "Zonings of Land, Based on the Importance for Tiger Conservation" (Figure 8), and criteria for the minimum management requirements for each zone (Miquelle, 1995):

ZONE 1: Highest level of protection, a region where protection of the tigers takes precedence over all other land uses. This zone is represented by *Zapovedniks*, *Zakazniks*, national and natural parks.

Management in the zone:

a) no logging;

b) 100% of forest cover except for natural openings;

c) no hunting;

d) no roads;

e) assessments of the impact on tiger population required for natural resources utilization or alteration of the tiger habitat.

ZONE 2: Critical tiger habitat. This zone is represented by unprotected areas, but a region where the tiger conservation is one of the most important components of the overall land-use planning.

Management in the zone:

a) only selective cutting;

b) 90% of forest cover;

c) hunting allowed , but elk and wild boar populations retained at combined densities equal to or greater than 10 per 10 km^2;

d) roads opened strictly for logging are closed after logging activities are done;

e) assessments of the impact on tiger population required for natural resources utilization or alteration of the tiger habitat.

ZONE 3: Mixed-use management zone. This zone is represented by areas where the tiger is found, and where they must be managed, but with the acknowledgment that other land-uses also have priority.

Management in the zone:

a) selective cutting preferred;

b) 70% of forest cover;

c) hunting allowed , but elk and wild boar populations retained at combined densities equal to or greater than 5 per 10 km^2;

d) roads opened strictly for logging are closed after logging activities are completed;

e) assessments of the impact on tiger population required for natural resources utilization or alteration of the tiger habitat.

ZONE 4: Buffer zone for the tiger.
Management in the zone:

a) logging allowed;

b) retained as forested lands, managed by Leskhoz;

c) hunting allowed according to hunting regulations;

d) roads opened strictly for logging are closed after logging activities are completed.

ZONE 5: Regions deemed unacceptable for the tiger habitation due to high human population, or inaccurate land uses.

6.2.6 Conclusions

The Habitat Protection Plan for the Amur tiger conservation developed by Russian and American Scientists is the best protected area system proposed. Being implemented, this system would be one of the best examples of protected territories, ever designed for an individual species (personal communication with international specialists). Thus, it is of primary importance to ensure that these proposals are implemented. However, at the moment this program faces enormous difficulties in the implementation, mainly due to unstable economy and corruption within the Russian institutional structures.

Other essential conservation steps are:

- prohibition of all large-scale clearcutting in Primorye and southern Khabarovskiy Kray,
- control of all the local forest enterprises using selective cutting technologies,
- orientation of the forest enterprises into forest restoration,
- restriction of the number of used roads, and close-down after usage,
- reduction of the hunting level of prey species (wild boar and elk),
- proper implementation of the Russian Federation Government Statement concerning the Amur tiger, and the National Strategy and Conservation Action Plan.

6.3 Amur leopard (*Panthera pardus orientalis*)

6.3.1 General information

The *Panthera pardus orientalis* is one of the most endangered big cats in the world. There are over 20 subspecies of leopard (*Panthera pardus*), found in both Asia and Africa. Eight subspecies are endangered, four critically. The Amur leopard, also called the Manchurian or Korean leopard, is a beautiful exotic predator and is represented in the IUCN Critically Endangered Red List. The species lost 80% of its wild range during 1970–1983 (Current Feline Species at EFBC/FCC, 1995). This is the only cold-climate subspecies of Asiatic leopards, which inhabits the mountainous coniferous-broadleaved forests, other leopards thrive in the tropics, even in deserts.

The Amur leopard occupies a remote area of the Chinese-Russian border and North Korea. In China and Korea they are on the verge of extinction, and in Russia they are estimated to number 30 adults.

There are about 157 Amur leopards in the zoos of the world, however only 10 of them are purebred (Shoemaker, 1989).

6.3.2 Historical trends of distribution and population size

Up to the beginning of the 1970s the data concerning the leopard was very poor. The literature is desultory and scant. In 1972–1973 the first leopard census was performed.

1) In the middle of XIX century investigators identified the presence of Amur leopard in different regions of Amur-Ussuri Kray (Figure 9). It was considered that the leopard inhabited the Ussuri river basin, from the sources in the south to the out-flow in the north, and all of the Russian territories to the south of the Ussuri river (Maak, 1861).

Przheval'skiy (1870) wrote about meetings with animals in the surroundings of Lake Khanka, and also in the whole of the Ussuriland Region, but less often than with the Amur tiger.

Schrenk (1859) considered that the leopard lived along the whole watershed of the Amur river and on the coasts of the Sea of Japan and the Sea of Okhotsk, and even in the Sakhalin Island. In south-eastern Zabaikalye it was possible to see the animal in the region closed to Nerchinskiy zavod (Cherkasov, 1867).

Before the 1900s, Arsen'ev (1914) defined the northern border of the leopard distribution from Lake of Khanka to the south of the city of Ussuriysk; to the Mountains of Przheval'skogo, and north to the eastern slopes of the Sikhote-Alin Mountains along the sea cost to the Bay of Ol'ga.

Based on knowledge of the leopard ecology, scientists believe that the northern border of the leopard habitat, described by Arsen'ev was the most realistic one. The leopard's appearance north of this border should only be considered as accidental (Pikunov and Korkishko, 1992). They also noticed that the described area had been a single habitat area for a long time and much earlier than from the end of the 19th century. At the time of Przheval'skiy's findings (1870), the habitat area had, probably, already been divided into three parts, namely, the Sikhote-Alin's area, the North-Western area, and the South-Western area. However, the habitat areas were not isolated from each other, and contacts between the leopards could occurred easily.

There was no survey concerning the size of the leopard population at that time. However, literature indicated that the leopard was a common species, but not particularly numerous.

2) Along with the rapid industrial development and human population growth in the beginning of the 20th century suitable territories for leopard habitat continued to decrease. The distance increased between the three habitats described above. Transitions between the Sikhote-Alin's habitat area and the two others stopped and the Sikhote-Alin's area became isolated. The well-established link between the North-Western and the South-Western areas were disturbed. The last two areas were the eastern parts of the big habitat area in the Eastern-Manchur Mountains, located in China.

Baykov (1927) mentions that in 1912, two leopards in Amur region and 11 in Primorye were killed by hunting. Solov'ev (1926) considers that at the end of the 1920s, 2–3 leopards were killed per year by hunters in the Ussuri region, however this figure seems to be an underestimate.

3) During the Soviet period the leopard habitats were not permanent, the borders changed and decreased. In the 1930s, the leopards disappeared from the western slopes of the Sikhote-Alin range and the eastern slopes of the habitat area moved to the south. The species also disappeared from the Bol'shoy Ussurki, the Bikin and the Khor river valleys, the Ol'ga, the Evstafia, and the Valentina bays, and from the Lazovsky natural reserve.

Little is known about the size of the leopard population during this time period. Different authors indicate a predator rarity (Bromley, 1956). However, the leopards were not rare at the west coast of the Amur Bay (Vasil'ev *et al.*, 1965).

Due to the small population and according to the Kraypotrebsoyuza data, the leopard has never been a primary hunted species. During the period 1934–1965, 39 leopard skins were marketed in Primorye, which means one to six killed individuals per year.

A ban on the leopard hunting was declared in 1956. However, poaching and killing near deer farms continued. During the period 1953–1973, 58 individuals were killed in the South-Western and the North-western areas (Pikunov and Korkishko, 1992).

4) During 1972–1973 the first leopard census and field investigations were carried out by Abramov and Pikunov. The census defined borders and the scale of the habitat areas at that time (Figure 9).

This census resulted in the following conclusions:

- all of the three original areas were completely isolated from each other;
- the Sikhote-Alin habitat area was approximately 500,000 ha. The borders of the habit, where the species lived permanently, could be defined as the mountain range Partizanskiy, the right tributaries of the Kievka river, both side tributaries of the Partizanskaya river, the south spurs of the mountains of Przheval'skogo, the Pidan range, the Steklyanuxa river, and the left tributaries of the Artemovka river. This areas was inhabited by 8–10 individuals (Abramov and Pikunov, 1974);
- the North-Western area was 140,000 ha and the border begun at the origins of the Bol'shaya Ussurka river near the State Russian Border with China, continued to the south-east, including the Propast' and Gorbatuha stows, turned south, crossed the Srednyaya river, including the river tributaries, continued to the south-west, and turned to the west. The leopards did not live permanently in these areas, 5–6 individuals visited this habitat area for short periods of time.
- the South-Western area was some 500,000 ha. The border started south of the Razdol'naya river, including the sources of the Borisovka river and went straight to the east, after crossing the river near the Pushkino settlement the border turned to south-east, rounded the watershed of the Bol'shaya Kedrovka river, near the settlement Terexovka it turned to the south, and continued along the right side of the railway Vladivostok-Hasan to the Gryaznaya river. From the river the border turned to the east of the coast of Peter the Great Bay, along the sea coast to the eastern border of the Kedrovaya Pad natural reserve, deflected to west, crossed the Narva river, and near the Poyma river again met the railway Vladivostok-Hasan. From the railway it turned to the west, and later to the south along the state border to the Hasanskaya Lowland, and again it crossed the state border. In 1973, the leopard population consisted of 25–30 individuals, of which 12–15 lived permanently in the area, and there was a range of other 13–14 leopards which partly inhabited the territories of China (Abramov and Pikunov, 1974).

Thus in 1972–1973, the total Amur leopard population can be estimated to 38–46 individuals.

5) In 1983–1984 a new leopard census was carried out by the scientists Pikunov and Korkishko. They revealed that the size of the leopard population of the South-Western habitat area had not changed, and approximately 25–30 leopards still inhabited this area. Analyses of the leopard distribution in that area have shown that in the south tracks of the leopard were only present in the upper streams of rivers. This corresponded with the distribution border of the remaining coniferous-broadleaved forest, which was less disturbed by man-made activities. In the north leopards occurred in more wide bands, and the presence was also correlated with the forest distribution.

These investigations did not reveal any leopards in the North-Western habitat area. According to interrogation by forest workers, sport-hunting, local people, and border-guards the last leopard appearance in that territory was in the winter of 1978–1979. Later research confirmed that the leopards had left these territories (Pikunov and Korkishko, 1992).

Detailed investigations of the Sikhote-Alin's habitat area could not find any traces of the leopard.

6) In the 1960s, in China the Amur leopard was still widely distributed, but in the 1970s the range and number had decreased due to logging and human settlements. During a wildlife census during 1988–1992, a population of 8–19 leopards was estimated for the Heilongjiang Province. Chinese specialists believe that some of the leopards live in the Jilin Province, but there has not been any special survey in this area (Korkishko *et al.*, 1995).

6.3.3 Current status and future trends

In order to describe the present conditions with respect to the status of the Amur leopard, the following conclusions can be made:

- of three original leopard habitat areas in the Russian Far East two – the Sikhote-Anin's and the North-Western – have been lost due to changing environment during the last 20–30 years and the habitat destruction is estimated to continue.
- according to the 1984 census, the last remaining shelter for the Amur leopard in the world is located in the south-western part of the Primorye region, namely in the area of the Kedrovaya Pad' Reserve Zapovednik, where 25–30 animals inhabit a territory of approximately 500,000 ha. According to unofficial data the population had decreased to 15–20 individuals in 1995.
- an expedition carried out by Russian scientists in July–August 1995 found no signs of the leopard in the Heilongjiang Province of China (Korkishko *et al.*, 1995),
- there is no official statistics available concerning the leopard status in North Korea. However, the situation is estimated not to be better than in China due to the fact that leopard body parts have high commercial values, used for Tibetanian medicine purposes, and
- the genetic situation of the population in the wild is unknown. Of 157 leopards living in zoos only 10 are purebred, the others are hybrids with a hybrid value from 0.250 to 0.625.

It is obvious that without urgent measures the Amur leopard is already doomed to extinction, probably within a couple of years.

6.3.4 Genetic conditions

Genetic diversity is a critical component of the issue of biodiversity. The loss of genetic variation is less obvious than the losses of species, but probably much more severe. The genetic diversity within species allows a species the opportunity to evolve under changing environments and selection pressures.

Genetic conditions of the leopard population in the wild

Due to the small size of the wild population the threat of extinction is not only a result of ecological causes, but through loss of genetic diversity as well.

In some natural animal populations there is a disproportion between breeding males and females. Such disproportion leads to a lower genetically effective population compared with an even-distributed population. This is also the case with the Amur leopard population. Due to the existing social organization within the leopard population, there is one male on three females (Korkishko, 1986). Further, due to of the small size of the population the leopard generations are overlapped, and causing inbreeding. Thus, based on the formula presented by Franklin (1983), the critical size of the population can be calculated:

$$\frac{1}{N_e} = \frac{1}{4N_m} + \frac{1}{4N_f} \quad ,$$

where N_e is the genetically effective population number; N_m is the number of males in a population; and N_f is the number of females in a population.

The minimal genetically effective number of the population should not be less than 200 individuals for short-term survival, and not less than 500 for long-term survival, in order to avoid negative features of inbred depression. In 1983, the real population was estimated to 12–13 individuals (Korkishko, 1989). It is quite evident, that the population already has a

substantial inbreeding. Closed inbreeding, in turn, can be a cause for different diseases, which affect the birth and death rates, and number of cubs in the hatch. It is noticed that, for the period 1976–1986, the average number of cubs in hatch has decreased from almost 2 to 1,6 (Korkishko, 1989).

Genetic conditions of the leopards in zoos

At present, 157 individuals of the Amur leopard live in the world zoos (Gorgas, 1995). Of these, 114 leopards live in 22 European Zoos.[6]

It is evident that only 10 leopards are purebred (hybrid value equal to 0.0000), others are hybrids with a hybrid value of 0.2500–0.6250 (Shoemaker, 1989, and personal communication).[7] Unfortunately, it is assumed, that one of the major origins of the zoo population was not an Amur leopard (*Panthera pardus orientalis*). It was an individual which arrived at the Frankfurt zoo from Hong Kong on 20 December 1963. This individual deviates from the *P.p. orientalis* sub-species by color and relatively short fur. Later, blood analysis has confirmed that this leopard belongs to other subspecies (Gorgas, 1995).

Among 10 purebred leopards, seven are males, and three are females. This is an unfavorable sex ratio. Moreover, it is estimated that in captivity 11 males are born on every 10 females. Also, during the first years of the life-span, more females than males die.

Nine purebred leopards are right now involved in the European Breeding Program (Sarah Christie, personal communication). However, to restore genetic diversity in the zoo population, nine animals is not a sufficient number.

Recently four additional purebred leopards were found in Indonesian Zoos, which stem from Korea (personal communication). It would be of great importance to involve these animals in a future breeding program.

6.3.5 Main causes of extinction

The leopard extinction in Russia is caused by direct and indirect man-made activities. The first and the most important reason for the population decline is the direct withdrawal of suitable habitat areas in order to enhance deer farms, agriculture, and coal mining enterprises. Forest fires and inappropriate forest management practice also lead to reduction, deterioration, and fragmentation of habitat areas, and prevent the leopard to reach its feeding places. Poaching (for illegal trade of leopard products), and straight killing on the territories of neighboring deer farms are other serious problems.

Habitat destruction and fragmentation

Natural habitation, where the Amur leopard prefers to live permanently, are the vast mountain formations with both steep and gentle slopes, covered with coniferous-broadleaved and mixed-broadleaved forests. Favorable places, for living and hunting are areas covered with forest, mountain territories with narrow watershed ranges, and steep slopes. The preferable altitude is about 500–700 meters, and preferably old growth forests should have a stocking 0.4–0.6 with open undergrowth. Roe deer is the most common prey and is usually available during the whole year. Other prey, like spotted deer, wild boar, elk, manchur hare are much more abundant (Pikunov and Korkishko, 1992).

Currently nearly all of the leopard habitats have been transformed by man-made activities. Most often the vegetation of the habitats is now represented by forest formations heavily alternated through repeated fires and logging.

[6] Leopards in other zoos of the world have origins from the European Zoos.

[7] Hybrid values are only theoretical calculations, based on hybrid values of parents. The individuals from the wild are considered as purebred animals.

Alteration of the natural vegetation started in the beginning of 20th century, when migrators started the Far Eastern industrial development. In the southern Primorye, they frequently used forest fires for the preparation of agricultural fields. It resulted in the introduction of pyrogenic plant communities. These types of vegetations increase the fire danger by itself. At present a remarkable part of the territory is regularly burnt, and the process of forest degradation continues and is becoming more and more irreversible.

Of all the habitat areas, only the South-western habitat (300,000–350,000 ha) corresponds partly to all the requirements for a permanent habitat area. The South-western habitat is located in the southern subzone of the mixed coniferous-broadleaved forest zone. Due to anthropogenic disturbancies, the forested area has decreased substantially, and in many places the vegetation is in the secondary stage of succession. Nowadays, the forested area of the Hasanskiy region composes 48% of the total land area and the same is valid for the Nadezhdinskiy region (Pikunov and Korkishko, 1992). Natural vegetation, or vegetation slightly alternated by human activities, is saved as narrow bands along the State Border to the north. There are relatively untouched forests in the central part of the Kedrovaya Pad' natural reserve. The natural vegetation is here represented by cedar-black fir-broadleaved-liana forests and the northern slopes and sources of rivers and creeks are covered with coniferous-broadleaved forests. The southern slopes are characterized by natural and secondary oak and mixed forests.

Other parts of the region are covered with secondary stage succession vegetation of oak forests, interchanging with bushes of hazel and lespedeza, and high-grass dry meadows and wetlands.

The North-Western area has been altered significantly. The territory has been lost as a permanent leopard habitat. Small and middle-sized rivers have been changed for agriculture purposes. A narrow band (50,000–60,000 ha) along the state border is now the only place suitable for short-term habitation. Such places are characterized by hornbeam-broadleaved forests with elements of cedar and oak and with patches of high density undergrowth.

In the Sikhote-Alin area, the middle-sized river area of approximately 150,000 ha on the eastern slopes of the Sikhote-Alin mountains, could be referenced as an area where the leopard could live permanently. Places, where the leopard could stay periodically, occur on the western slopes of the Przheval'skogo range, and in the high mountain region (the total are is 200,000 ha). The areas with small rivers have been heavily changed by man. In these latter areas, the leopard can only stop from time to time and the area is of about 150,000 ha (Pikunov *et al.*, 1989).

Intensive human activity in the region not only destroys habitats, but also leads to a remarkable fragmentation. Even though a stow would be comfortable for the living of a leopard, the area is too isolated from other suitable habitats by unfavorable patches and will not be occupied by the leopard. This is the major reason for no occupancy by the leopard on what seem to be suitable habitats.

(a) Relationship to man. The leopard avoids man extremely carefully. It trys to avoid any contact, even though there is no real threat. If human disturbance is long-lasting, the leopard leaves its home area. In 1979, in the Kedrovaya Pad' natural reserve, people often used a path in the home territory of a leopard female. As the result the female left her home range for several years (Pikunov, 1992). When the leopard defines his home area the first criteria of choice seems to be inaccessibility of the territory by man.

(b) Leopard relationship to logging practices. Literature and all field investigations indicate that the leopard distribution is correlated with forest practices. The leopard prefers coniferous-broadleaved or mixed-broadleaved forests of the primary stage of succession and secondary succession oak forests. The leopard avoids treeless spaces, open woodlands, and bushes. In executed censuses and field research no leopard tracks were found along the railway Hasan-Ussurisk, or along the Amur Bay coast. These territories are characterized by absence of dense

forests and have gentle mounds and lowlands covered with woodlands, and an interchange with bushes and individuals trees (Pikunov and Korkishko, 1992).

The leopards do not live permanently in reforested areas. Such areas, especially in patches of clearcuts, are characterized by a high density of bushes. The leopard will visit this landscape type periodically for hunting.

The current forest management regimes, used in the leopard habitats, are extremely unfavorable for the leopard. Local logging enterprises (*leshozy*) should use intermediate fellings. In practice, under a mask of intermediate felling, all commercial wood is harvested as industrial harvests. The enterprises even cut such valuable species as Korean pine and Manchurian walnut, which provide food for many animal species. For example, in the Barsovy *Zakaznik* only young small-sized trees and bushes are left after a sanitary felling, which usually also perish due to inappropriate harvesting technology. At present, forests are heavily harvested in the areas of the Anan'evka, the Nezhinka, the Kraunovka, the Barabashevka and the Gryaznaya rivers (Pikunov and Korkishko, 1992). Regeneration is very poor in these areas. Moreover, by the artificial reforestation, tree species are used which do not have any food value. Therefore, the local forest management is only oriented toward timber mining. Thus, these practices and continuous forest fires caused by man, deprive the leopard and their prey habitats.

The leopard prey, roe and spotted deer, prefer to live in mosaic landscapes, where forest patches are interchanged with dense bushes and meadow vegetation. It provides good protection and food supply. Therefore, mosaic vegetations, as a result of man-made activities, may have some positive effects on the space distribution of ungulates. In the census of 1983 the highest density of roe deer was registered in mixed and broad-leaved forests. The density was lower in coniferous and oak forests and also in the edges of forest and treeless patches (Pikunov and Korkishko, 1992). Low density of roe deer in food-rich places like oak forests and woodland areas might be explained by easy access of such places by man, and hence by increased disturbances and poaching. It is poaching and vulnerability which pushes the animals out of rich places to places with less food resources. The leopard distribution is following the same pattern. The highest density of the leopard population is in coniferous-broadleaved forests, where the prey density is lower, but the disturbance factor is less. Perhaps, such distribution of predators and prey is an optimal compromise of favorable and unfavorable environmental factors.

Small-scale clearcutting, in places where the leopard does not live permanently, could even play a positive role for increased food resources for his prey if other disturbances are minimized.

(c) Roads. As many other animals the leopard is not very cautious with respect to traffic and roads. During night time it is caught by car lights, while crossing the roads. Usually, the leopard stops for some period of time and only then crosses the road. This makes them vulnerable to car accidents and an easy target for poachers.

Food resources

Most predators are on the top of the trophic chain of the ecosystems. Big cats need a high density of animal prey, first of all ungulates. Moreover, the ungulate populations should not only be available in great numbers, but should also be stable for longer periods of time. Predator-prey relationships are usually stable and maintained in balance in undisturbed ecosystems.

The primary prey of the leopard is, as stated above, roe deer (*Capreolus capreolus L.*). This ungulate species constitute 85% of the total leopard prey (Pikunov and Korkishko, 1992). Spotted deer (*Cervus nippon Temminck*) is the second most important prey species.[8] Other prey are wild boar (*Sus scrofa ussuricus*), Manchur hare (*Lepus munchuricus*), raccoon dog (*Nyctereutes procyonoides L.*), badger (*Meles meles*) and several other species.

[8] In places where the density of spotted deer is much higher than roe deer, the first one is becoming the main food resource.

According to research data of 1972–1973, the density of the leopard distribution is strongly correlated with density of ungulates (Pikunov, 1992). Therefore, decreased ungulate populations, or changed migration paths of the ungulates result in decreased leopard population.

Poaching of ungulates destroys the leopard food resources significantly. In some places the density of roe deer is only 3–5 individuals per 1,000 ha, whereas in the Kedrovaya Pad' natural reserve the density reaches 20–25 individuals per 1,000 ha.

Low density of ungulates has also been intensified in China by Russian scientists. They noticed that the investigated areas can potentially be inhabited by leopards, provided that the ungulate density is increased (Korkishko *et al.*, 1995).

Conflicts between leopards and deer farms

Southern Primorskiy Kray is the region, where agriculture has been developed most intensively. Deer farms are important and stable parts of the economic income for that region. Farmers cut off the deer antlers in velvet and sell them to Asian pharmacies. Most of the deer farms have been created in the leopard habitats. An area of 40,000 ha is fenced. The leopards, used to their former hunting areas, continues to visit these farms. The predator considers the farm deer as natural prey and hunts them. The existing 2–2.5 meter fence, constructed in an inappropriate manner, promotes the predator penetration inside the farms and the farmers consider the leopard an enemy and kill him.

Damage, produced by the leopard in the territories of deer farms has developed a hatred by man to the predator. This is the reason for leopard elimination in the past, and it still continues. In many cases, death of ungulates caused by other reasons in this area, is blamed on the leopard.

Poaching

Despite the ban on leopard hunting implemented in 1956, poaching still continues. During 1956–1976, 52 leopards were killed and approximately 30 were caught for zoos. At the time of the introduction of quite strong measures of punishment for poaching, information concerning the poaching became hidden and unofficial. However, the leopard killing continues, even inside the protected territories.

According to official data, more than 5 leopards are killed every year and several of them are young individuals caught by traps set up for leopards and other animals, like badger or raccoon dog. Hunting dogs very often drive the leopards up in the trees, and there the leopards are killed by poachers. Despite the existing measures of punishment, poachers very often manage to avoid it.

6.3.6 Conservation measures, existing and future protection needs

In order to protect the Amur leopard in Russia some conservation measures have been undertaken. Since 1956, the hunting of the leopard has been banned. The species is included in the Russian and the former USSR Red Data Books. *Barsovy Zakaznik* has been created especially for protection of the leopard. There are several decrees, issued by the federal government concerning protection of endangered species and their habitat areas. However, the effectiveness of all protection measures are extremely insufficient due to lack of control of their fulfillment.

Existing protected areas

The home range of one leopard female is 50–100 km^2, depending on the quality of the habitat area. The home range of a male is much larger, and covers the areas of 2–4 female home ranges and sometimes his area exceeds 300 km^2 (Pikunov and Korkishko, 1992).

Existing protected areas, directed toward protection of the leopard in the RFE (Figure 10), are too small to conserve the remaining leopard population, and to restore the population to

at least 50 adult breeding females (see chapter 6.2.6.1). Thus, the creation of a network of protected territories is a vitally important measure for the survival of the leopard.

Taking into account the species' critical situation, and the fact that the Amur leopard as a species has a very low reproductive capacity,[9] it seems to be obvious that an expansion of the protected areas is not sufficient. A survival and conservation plan should be developed urgently.

(a) Kedrovaya Pad' Zapovednik (strict natural reserve). The Kedrovaya Pad' is the first natural *Zapovednik* in the Russian Far East, established in 1916. Administered by the Russian Academy of Sciences, the reserve provides habitat for 60 species of mammals including those who are in the Russian and World Red Data Books such as the Amur leopard, the Amur tiger, the Himalayan bear, the Amur forest cat, and the spotted deer.

The Kedrovaya Pad' is the only reserve which contains some well-saved habitat areas for the Amur leopard. However, the area of the reserve, 17,890 ha, is too small to be sufficient for the protection of the leopard. Due to the small area, any anthropogenic disturbance outside the *Zapovednik* indirectly influences the environment inside. Moreover, the surrounding territories are so changed by human activities that there is no hope to restore the primary natural complexes of these territories, even though special measures are undertaken.

(b) Barsovy Zakaznik (partially protected area). *Zakazniks* are usually established for protection of particular plant or animal species. This type of protected areas is organized in order to restrict some economic activities temporarily or permanently and often only during certain seasons. In reality, *Zakazniks* do not fulfill their major protection functions, as they do not provide any protection of the species habitat areas. Different human activities, taking place inside of *Zakazniks*, lead to distortion of the ecological conditions of different species, which in turn, result in decreased populations.

The *Barsovy Zakaznik*, with a protected area of around 100,000 ha, was established with the objective to protect the Amur leopard. However, inside the *Zakaznik*, commercial timber harvesting is carried out and the staff is too small to prevent poaching inside the *Zakaznik*. Thus, at present, the Barsovy *Zakaznik* does not perform its main function of protection.

Recommendation for protected areas

In the Primorskiy Kray Ecological Program, a government-designed ecological action plan to year 2005 is describing the existing Kray system of protected areas and a perspective for the future protection. Classification of protected areas in the Program is based on the principle of ecosystem complexity, which is the most important factor for conservation of species. Some areas, recommended to be protected by the Program, could also play a positive role in the Amur leopard conservation.

(a) Borisovskoye (or Shufan) Plateau. *Borisovskoe Plateau* (Figure 10) is a very important area for the Amur leopard. It has been recommended as a protected area, not only by the Primorskiy Kray Ecological Program, but also by international specialists. This is the largest remaining habitat area for the last population of the leopard. The *Plateau*, covered with cedar, black fir and mixed-broadleaved-liana primary forests, is an area of great animal and plant diversity. Beside the leopard, other endangered and rare species live here, including the Amur tiger, the Himalayan black bear, the Amur forest cat, the Amur goral, the spotted deer, the spotted bush warbler, and the Kruper's nuthatch.

The Primorskiy Kray Ecological Program recommended the protection of an area of 103,400 ha of the *Borisovskoe Plateau* as a branch of the Kedrovaya Pad' *Zapovednik* and with a buffer zone of 115,000 ha (Primorskiy Kray Ecological Program, 1993). It should occupy the

[9]The Amur leopard female produces 1–4 cabs every 2–3 years and many of them die due to different reasons. Thus, the total reproduction by one female consists of 4–5 cubs during her life cycle.

territories between the Gryaznaya and the Kraunovka rivers, and from the State Border to the railway Ussurisk-Hasan, excluding settlements, industrial, and agricultural enterprises.

International organizations, such as the Friends of the Earth-Japan, the Hornocker Wildlife Institute, also care about a creation of a protected area in the *Plateau* in the form of a national park. However, the initial and economic assessments prepared by scientists are right now under consideration by the local Department of Game Management (*Upravlenie okhoty and ohotnichego khoziastva*), which means that in the case of a positive decision, the *Shufan Plateau* will only get a *Zakaznik* status, which is not enough protection in the current situation.

A protected *Borisovskoe Plateau*, combined with the *Kedrovaya Pad' Zapovednik* and the *Barsovy Zakaznik* would give the leopard a chance for survival in nature. However, intensive selective logging is already threatening the forest ecosystems in the *Plateau*, particularly the ash forests in the river valleys. Moreover, the forest service recently declared that they are considering opening up the *Shufan Plateau* for large-scale logging.

(b) Expansion of the Barsovy Zakaznik. It was recommended by the Kray Ecological Program to expand the *Barsovy Zakaznik* in an area of the upper and middle streams of the Amba river (Figure 10) and the proposed area expansion is about 28,000 ha.

Some scientists also consider that the Gryaznaya river basin should be added to the *Barsovy Zakaznik* (Korkishko and Glebov, 1984).

Restoration of former habitat areas and their protection

A big hope for the survival of the leopard is the restoration of former habitat areas. Relatively favorable environments (in term of food resources and habitat conditions) in the coastal area of the Lazovsky *Zapovednik* and surrounding territories give an opportunity to restore the Sikhote-Alin population of the Amur leopard (Figure 10). The Primorskiy Kray Ecological Program (1993) envisages the expansion of the Lazovsky *Zapovednik* by adding the Milogradovka and Chernaya river basins (the proposed reserve area is 90,000 ha and with a buffer zone of around 440,000 ha), and by protection of the Krivaya river basin (an area of 62,500 ha). These are the territories of the former Sikhote-Alin habitat area of the leopard. The possibilities for a successful leopard reintroduction and adaptation in this former habitat will be entirely dependent on restoration measures of the habitat.

Additional proposals for a habitat protected network

Network of protected areas, developed by groups of international scientists for the Amur tiger conservation (Miquelle D., 1995; see also Figure 8), could help the leopard as well. The Upper Ussuri National Park, the Southern Primorye Nature Park, the Lazo Ecological Corridor, and the Southern Sikhote-Alin Corridor included in the tiger conservation plan as perspective protected areas, would provide a habitat for the leopard as well. It would also connect the Sikhote-Alin habitat area with the Ussuriyskiy Zapovednik, where the leopard could stay periodically. An ecological corridor between the South-Western habitat area and the Sikhote-Alin area should also be developed.

Due to the biological diversity of the Southern Primorye territory the protection level of the whole region should be increased.

International Programs concerning the Amur leopard

The critical situation of the Amur leopard is attracting increased international attention. In 1992, the Russian-American project "The Ecology of the Far Eastern leopard in the South-West of Primorye" commenced it's work. Scientists of the Russian Academy of Sciences and the Hornocker Wildlife Institute, using the radio-collar methodology, are trying to study different

aspects of the leopard ecology, in order to answer questions concerning the conservation of the species.

The IUCN cares about the leopard within the European Breeding Program, which is carried out in the European Zoos. They are trying to breed animals in the zoos but the program is complicated due to the low number of purebred individuals (see also Section 7).

6.3.7 Conclusions

To protect the Amur leopard and its natural habitats the network of protected areas should be further developed. The network should include an increased level of protection within the existing territories, restoration of former habitat areas, and creation of new protected areas. However, due to the critical situation, additional efforts for saving the leopard must be undertaken:

- changed forest management; all types of clear felling must be prohibited, not only in the leopard habitat places (existing and future protected areas), but also in adjacent territories. Sanitation fellings should be operated under new norms and the forest enterprises (*leshozy*) should be oriented toward forest restoration,
- improvement of food resources; a temporary ban on all types of hunting of ungulates in the areas of the leopard habitats until the ungulate density has reached 15–20 individuals per 1,000 ha,
- exclusion of human disturbance in the leopard habitats; all areas with a permanent living by the leopard should be assigned to the strictest level of protection,
- increased responsibilities with respect to maintenance of proper fences around deer farms,
- creation of a species farm, where the leopards could breed in semiwild conditions followed by an introduction to the wild,
- organization of an effective protection against fires, poaching, and dogs,
- organization of a strict control for fulfillment of all nature protection legislative decrees,
- additional field research and comprehensive genetic analysis, and
- extension of public awareness and environmental education.

6.4 Himalayan Black Bear (*Ursus (Selenarctos) thibetanus*)

6.4.1 General information

The Himalayan black bear (*Ursus (Selenarctos) thibetanus*) is one of nine species of Family Ursidae (bear). In Russia, the Himalayan bear, also called *Belogrudy* because of a white stain on the upper part of the breast, belongs to Category II of the Russian Red Data Book.[10]

The Himalayan black bear inhabit the South-Eastern Asia, from the Japanese Islands to the Malacca Peninsula in the south, and to Afghanistan and Pakistan in the west, including the northern regions of India.

In Russia, the bear occupies Primorskiy Kray and the southern parts of Khabarovskiy Kray, which are the peripheral northern part of the world geographical distribution (Russian Red Data Book, 1985). In these areas the bear inhabits the cedar-broadleaved and the mixed-broadleaved forests. In the beginning of the 1970s, the population in Primorye was estimated to 1,700–2,000

[10] According to the Russian Data Book classification, Category II is constituted by those species/subspecies and habitat areas, which decrease most rapidly. Without urgent protection measures these species/subspecies are potential pretendants for Category I.

inhabitants (Abramov and Pikunov, 1974), which allows to assume that the total number of the bear on the Russian territory is 3,500–4,000 individuals.[11]

6.4.2 Trends in geographical distribution and population size

Distribution

A couple of decades ago, the Himalayan black bear was a common species inhabiting the Russian Far East.

In 1957, Sysoev (1957) wrote the following about the geographical distribution of the bear in Russia:

> "The northern border for the bear distribution begins at the state border with China upon the Byreinskiy range of the Beranzh river (pritok Urmi), follows to the north-east upon the Kukanskiy range to the origin of Kura river. Here it turns to the east and goes down along the El'ban river to the Amur river, along the Hungari river to the sources of the Hoso river. Further, it follows the middle stream of the Anuy river, in the Anuy-Khor's and the Khor-Muhensk's watersheds to the origins of the Muhen river; there it crosses Khor river and goes from the Chuken-Sykpai's watershed to the central range of the Sikhote-Alin Mountains. The eastern border starts at the southern part of the Sikhote-Alin Mountains, rounds the upper stream of the Samarga river and its tributaries, and part of the Kopi river, and reach the Sea of Japan to the north of the Kopi settlement" (see Figure 11).

In the book "Rare Vertebrates of the Soviet Far East and their Protection", issued in 1989, the following was stated on the borders of the bear distribution (according to Bromley, 1965, and Kucherenko, 1974):

> "The habitat area follows a narrow band of the left side of the Arhara river, the southern slopes of the Bureinskiy and the Dzhaki-Unahta-Yakbyiana ranges to the Gorin river. Here the border crosses the Amur river, and follows the western slopes of the Sikhote-Alin range and goes to the south of the Bol'shaya Ussurka river watershed. From there, the distribution area occupies all the forested part of the Sikhote-Alin range. In the north, the border follows the Sea of Japan and reaches the watershed of the Maksimovka river. Individual parts of the distribution area are still retained around the Pogranichny range, and in the Borisovskoe Plateau and the Black Mountains, where the border goes down to the south to the Kraskino settlement. In the described area, the species is absent in the forestless areas, in valleys, and in high mountains covered with fir and spruce" (Figure 11).

The difference in the above bear distributions [and the bear disappearance along the sea cost, between the settlements Kopi and Maksimovka (Figure 11)], can be explained by two factors: 1) inaccurate description of the borders; or 2) a disappearance of the bear in coastal zones due to changed forests. Thus, Bromley (1965) wrote:

> "... at present there is almost no cedar in the broadleaved forests in Primorye, 20–30 km along the sea cost and 90–120 km along the eastern side of the Ussuri river, as a result of cutting and fires ...".

There are no more recent surveys concerning the geographical distribution of the species. However, Kucherenko (1981) identified some change in the border line of the habitat of the bear on the western part of Priamurye. In the Amur region, the black bear had became rare even

[11] Russian Red Data Book indicates a total number of 6,000–8,000 bears, this figure, however, seems to be overestimated.

Table 6. Average density of the Himalayan black bear in different types of forests (per 1000 ha).

Type of forests	Average density (in individuals)
Cedar-broadleaved forests	0.7
Broadleaved-cedar-spruce forest	0.5
Spruce-fir forests	0.2
Coastal oak forests	0.1

Source: Bazyl'nikov, 1977.

in the cedar-broadleaved forest of the central part of the Arhara river watershed. The author pointed out, that the bear may be extinct in these areas in the future.

The Himalayan bear is also rare in the southern and the western regions of Primorskiy Kray as well (Hramzov 1981).

Population size

There are no specific censuses with respect to the population size of the Himalayan bear in Russia. Until recently, this bear was considered a common hunting species. However, it is evident (Figure 12), that the number of bears registered for state purchases during the period 1934–1950 had decreased. Although these figures can not be indicators of the annual number of bears killed, it is probably an approximate reflection of the population development. It also should be noticed that the Himalayan black bear represents a major part of the commercial purchases of bears, due to the fact that the brown bear live in more inaccessible areas and to obtain him is much more difficult than the black bear (Bromley, 1965).

In 1974, Kucherenko (1974) estimated the size of the bear population in the Russian Far East to be more than 6,000 individuals. At the same time other biologists estimated the size to some 3,000 individuals (Abramov and Pikunov, 1974).

It is assumed, that decreasing rate of the bear population is 4–4.6 % per year (Batalov, 1977). Based on this assumption, the current population size can be estimated to be 1500–2500 individuals.[12]

6.4.3 Main causes for the decrease of the population

The main causes for the decline of the bear population are degradation of habitat areas due to logging and fires in cedar forest, decreased protective and fodder functions of biotops. Other reasons are human disturbances of bear dens and intensive hunting.

Habitat destruction and degradation

The existence of the Himalayan bear is strongly connected with cedar-broadleaved forests. The distribution of these forests defines the borders and habitat areas of the bear in the Russian Far East. Mixed-broadleaved forests are of second importance for the bear (Bromley, 1965).

Special censuses dealing with the relationship between the bear density and different biotops, carried out on the areas of *Zapovedniks* and hunting enterprises, have revealed the figures shown in Table 6.

It has been shown, that under optimal habitat conditions, the average bear density can reach 0.84–0.96 individuals per 1,000 ha (Batalov, 1977). Dunishenko (1977) estimated that the core of the bear population is located in the forests of the central mountains of the Khor, the Bikin,

[12]The present size of the population N can be estimated by the formula: $N = N_0 e^{-\alpha t}$, where N_0 is the initial size of the population (the population in 1974), α is the rate of population changes (in this case 0.04–0.046), t is time in years (in this case $t = 22$ years). Theoretically, approximately 1,500 bears live wild today in Russia, if the population size in 1974 was some 4,000 individuals; and approximately 2,500 bears, if the population size was around 6,000 individuals.

and the Bol'shaya Ussurka watersheds. Being a typical inhabitant of high trees in mountains, the bear absolutely avoids forests in slopes, open spaces, valleys, and riverlands.

The harvest of the virgin forests, especially the cedar-broadleaved forests, has deprived the bear its major habitats. The decrease in the extent of cedar forests (due to commercial harvesting) seems to be a primary cause of decline of the bear population.

(a) Food resources. Korean pine nuts, acorns of Japanese oak, nuts of hazels and Manchurian walnut, different fruits and berries, are the main food sources of the Himalayan black bear.

Sysoev (1966) found that the bear stomach content consisted of 60% cedar nuts, 30% oak acorns, and 10% fruits of grapes and blackberries. There was no observation of the bear eating ungulates or any other animals.

Cedar nuts and oak acorns are the major sources, from which the bear gains the fat for the winter sleep. Thus, well-being of the bear depends entirely on these species of trees.

(b) The bear dens. Logging leads to a population decline through the elimination and destruction of the bear winter refuges. It is a well-known fact, that the Himalayan bear arranges its dens in hollows of trees. The bear arranges most of the dens in living trees (80%). Half of the dens are located in lime (*Tilia*), and one third in cedar and cottonwood (*Populus*) (Sysoev, 1966).

The bear arranges his dens primarily in virgin forests, which have not been exposed to logging and fires. These are the best bear biotops in terms of their protective and fodder functions. Therefore, cutting of virgin forests, and especially cedar-broadleaved forests, leads to decreasing amounts of habitats and a degradation of the dominating bear habitats.

Besides harvesting, hunters are destroying the dens when they are trying to shoot the bear. Hunters cut the dens, and force the bear to get out by smoke. The bear never occupies such trees again. The number of such destroyed dens are estimated to thousands. According to Dunishenko (1977), of 100 trees with dens, 80 had cut dens.

The decreasing number of safe refuges increases the bear mortality by its main enemies, predators such as tiger and brown bear.

Hunting and poaching

Unregulated hunting and poaching also have diminished the population rapidly. In the 1970s, of 147 bears of both species (black and brown) registered as killed, 53.1% were black bears. Females with cubs constitute some 80% of the hunted animals and half of the bears are killed during winter in their dens (Dunishenko, 1977). Despite the existence of regulated hunting seasons, hunters do not follow any regulations (Dunishenko, 1977).

6.4.4 Existing and future protection needs

Existing protection measures

Until 1939 the Himalayan bear was considered to be a dangerous predator, and was allowed to be hunted and killed throughout the whole year. After 1940 the hunting is restricted to hunting seasons (Hramzov, 1977).

In 1975, hunting licenses were implemented in Primorskiy Kray and in Khabarovskiy Kray the hunting is completely prohibited since 1977. However, one of the major causes for the population decline, the destruction of the bear habitats, has not been regulated.

The Himalayan bear lives in all terrestrial *Zapovedniks* of Primorye (except for lands around the Khanka Lake). However, as mentioned before, the areas of the existing *Zapovedniks* are too small to maintain populations of big vertabrates, including the Himalayan bear. Decline in the number of bears has been noticed even in the territory of the Lazovsky *Zapovednik* (Bromley, 1965, and 1968).

Future protection needs

The following measures are required in order to protect the Himalayan black bear:

- A network of the protected areas has to be established: new *Zapovedniks* (or planned expansion of the existing *Zapovedniks*) should be based on an optimal living of evolutionary population units of the species. A number of new *Zakazniks* should be established and for this purpose a special census should be carried out in order to clarify the current size of the bear population and the distribution areas.
- Logging activities should be restricted or banned in the core areas of the bear distribution and special forest management rules should be implemented in other areas of the bear distribution. Reforestation should be oriented toward restoration of the main fodder tree species.
- Hunting of the bear should be banned until the size of the population has reached the level of the 1970s. At that point, hunting should be restricted by licenses, to hunting seasons, and to particular territories.
- Special measures of punishment should be established for the destruction of the bear dens.

6.4.5 Conclusions

The destruction of the habitats is a major cause of the decline of the Himalayan black bear population. Logging of the cedar-broadleaved forests, the primary bear biotop, has to be strongly regulated.

Present and future harvesting in the Bikin, the Hor, the Samarga river watersheds (where the core of the population is located) will accelerate the decline of the population.

6.5 Birds

6.5.1 Introduction

The Russian Far East, mainly the Primorskiy Kray, is the richest region of Russia with respect to bird species diversity. According to the maps of bird species richness (Ministry of Environmental Protection and Nature Resources, 1995), the total number of bird species in the Primorskiy Kray can be estimated to 380 (61% of the total number of bird species in Russia). The most reach areas in term of bird species diversity are the territories around the Khanka Lake (the Hasanskiy *raion* totally) and the Sikhote-Alin mountain forests.

In the Primorskiy Kray 33 species of birds are listed in the USSR Red Data Book (1985) and of which 11 species are in the IUCN Red Data Book.

Vegetation plays a determinant role in the formation of forest-dwelling bird communities (Simonov, 1987). Species diversity, structure and size of such populations are primarily correlated with the type and the structure of the forests where they live (Dubinin, 1960).

However, by a vegetation change, different bird species respond differently. Some of them, having a strong food specialization or strict affiliation to a particular habitat, decrease in numbers, or disappear totally. The Russian Far Eastern Siberian Grouse (*Dendragapus falcipennis*), Blakiston's Fish Owl (*Ketupa blakistoni*), Spotted Nutcracker (*Nucifraga caryocatactes*). Eurasian Nuthatch (*Sitta europaea*), and others belong to this group. Some of them are rare and/or endangered, and harvesting or fires in a particular forest can lead to increased threat to these species.

Some of the bird species have a wider range. These species can tolerate some changes in their environment.

In this section, short assessments of four endangered bird species of the RFE are carried out. The assessments are made for species mainly related to riverland forests. Harvesting of

these forests, which increased especially during the last couple of years, has caused a population decrease due to losses of suitable sites for breeding and changed water regimes. The result has been a decrease of available fish for the birds.

6.5.2 Blakiston's Fish-Owl (*Ketupa blakistoni*, Seebohm, 1884)

Blakiston's Fish Owl (*Ketupa blakistoni*) belongs to Category I of the Russian Red Data Book,[13] and has been included in Appendix II of the CITES, and is listed as a species which requires special protection according to the Russian-Japanese Convention on Migratory Birds (Red Data Book, 1985).

Distribution

In the Russian Far East the continental subspecies (*K.b. doerriesi*) inhabits watersheds of big rivers (the Khor, the Bikin, the Bol'shaya Ussurka) in the Primorskiy Kray. In Khabarovskiy Kray and in Priamurye the Fish Owl is now very rare. In Sakhalin Island and in the Southern Kuril Islands there are possibilities to see the island subspecies (*K.b. blakistoni*) (Rare Vertebrates of the Soviet Far East and their Protection, 1989).

In addition to Russia, the species inhabits North-Eastern China, the Hokkaido Island (Japan), and probably the northern parts of Korea (Rare Vertebrates of the Soviet Far East and their Protection, 1989).

Population

At present the population size is at a critical level. In 1973, Pukinskiy (1973) wrote that the Blakiston's Fish Owl was a common species in the riverland forests of the Bikin river. At that time it was possible to see an owl breeding pair every 10–12 km. In 1975–1976 at a distance of 250 km along the Bikin river, less than 70 individuals were registered (Pukinskiy, 1981). In 1938–1939, in the basin of the Bol'shaya Ussurka river 12–15 pairs were registered on every 100 km along the river. In 1980, the Blakiston's Fish Owl had become a big rarity in these areas and the number of birds had decreased by 50% (Pukinskiy, 1981).

Presently, not more than 15–20 individuals inhabit the forests of the Bikin river basin. There are no birds any longer in the forests of the Khor and the Bol'shaya Ussurka river basins.

Causes of disappearance

The riverland multilayered cedar-broadleaved forests are the preferable biotop of the Fish Owl. Virgin tree species of such forests are elms (*Ulmus propinqua, U. laciniata*), poplar (*Populus maximoviczii*), ash (*Fraxinus manchurica*), and Amur cork tree (*Phellodendron amurense*). In the crowns of these trees the owl arranges the breeding nests (Pukinskiy, 1973).

The harvesting of the riverland forests and the intensive industrial development of these regions (the Khor, the Bikin, and the Bol'shaya Ussurka river basins) have led to a substantial decrease of the Fish Owl population and brought it close to extinction. The harvesting of the riverland forests (mainly elms species) has accelerated especially during the last couple of years. The harvests lead to changed water regimes in the rivers and result in decreased fish populations (mainly salmon species), which in turn affect the Fish Owl population.

Measures of protection

The following measures of protection have to be introduced:

[13] Category I of the Russian Red Data Book includes species, which are on the edge of extinction. Populations of such species have reached a critical level, and habitats have been changed so dramatically that without special measures of protection these species can be extinct in the future.

- restrictions on logging of the riverland forests;
- creation of a network of special *Zapovedniks* and *Zakazniks*;
- creation of artificial nests;
- implementation of proper measures for punishments of poaching.

6.5.3 Scaly-sided Merganser (*Mergus squamatus*, Gould, 1864), and Mandarin duck (*Aix galericulata*, Linnaeus, 1758)

Scaly-sided Merganser (*Mergus squamatus*, Gould, 1864) falls within Category II of the Russian Red Data Book. The species is included in the former Soviet Union Red Data Book and the IUCN Red Data Book.

Mandarin duck (*Aix galericulata*, Linnaeus, 1758) also belongs to Category II of the Russian Red Data Book. The Mandarin duck is also included in the former Soviet Union Red Data Book.

Distribution

The geographical distribution for both species is the Russian Far East. The Mandarin duck also lives, beside of Russia, in the Japanese Islands, and probably in China and Korea (Rare Vertebrates of the Soviet Far East and their Protection, 1989).

In the Russian Far East the Scaly-sided Merganser inhabits coniferous-broadleaved forests in the valleys of the Sikhote-Alin rivers: the Kievka, the Samarga, the Kema, the Bikin, the Bol'shaya Ussurka, the Khor, the Sukpai, and others. The species also lives in forests of some river basins in the Khabarovskiy Kray, and at the western side of the Amur river.

The Mandarian duck uses the same biotops and inhabits the same distribution areas, but also inhabits the eastern side of the Amur river, the valley of the Ussuri river, the Prikhankayskaya lowland, the southern Primorye, the southern part of Sakhalin Island, and the Southern Kuril Islands (the Russian Red Data Book, 1985; and the Rare Vertebrates of the Soviet Far East and their Protection, 1989).

Population

The populations of these species of birds are decreasing rapidly. In 1980–1981, along the Bikin river it was possible to see Scaly-sided Merganser breeding pares every 6–8 km. The total population at the Bikin river was estimated to 120–150 pairs (Shibnev, 1985). There are no data on the current population available, but during the last 15–20 years the population in the Khor river basin is estimated to have decreased by 20%, in the Bikin river basin by more than in 10%, and in the Bol'shaya Ussurka river the species has disappeared completely (the Russian Red Data Book).

In the 1960s, the Mandarian duck was one of the main hunting trophies. The species flocks were a common phenomena at the Bikin river (Shibnev, 1985). In the beginning of the 1970s, a pair of Mandarian ducks bred every 2–3 km along the main stream of the Bikin river (the maximum density was 1–1.5 pairs per km). In the beginning of the 1980s, the number of the birds was reduced by half. In 1975, the total number of the Mandarian duck population (within the Bikin river watershed) was 550–600 breeding pair (Shibnev, 1985). During 1964–1974, in Priamurye the population number decreased by 50% (Roslyakov, 1977). The Mandarian duck disappeared during the same time period from the basins of some rivers in the south of Primorye (Polivanov, 1981).

Basic causes for the populations decrease

The major force for causing the decline of the populations of both species is the harvesting of the riverland forests, which are rich on hollow trees. Both of the species arrange their breeding nests in hollows of elms, poplars, and oaks. In places where the forest has been harvested, and the river shores have become open, the species do not build their nests. Also, log rafting, and motor boats scare and kill the young hatches.

In addition to harvesting, poaching and changed water regimes (by the industrial development) affect the species. If the industrial development of the habitat regions will continue with the same rate as before both the Scaly-sided Merganser and the Mandarian duck will be under a big threat in the Russian Far East.

Protection needs

the following protection measures are required:

- restrictions on harvesting of riverland forests,
- creation of effective protection areas (first of all within the Bikin river basin),
- give *Zakaznik* status to all places where the species have breeding nests,
- ban industrial development within breeding areas, and
- restrict access of people and motor boats to breeding areas during the nesting period.

6.5.4 Siberian Grouse (*Dendragapus falcipennis*, Hartlaub 1885)

Siberian Grouse (*Dendragapus falcipennis*, Hartlaub 1885) is a rare endemic species belonging to Category II of the Red Data Book, and is registered in the former Soviet Union Red Data Book.

Distribution

Siberian Grouse inhabits territories of the eastern part of Zabaikal'ya, areas from south-eastern Yakutia to the coasts of the Sea of Okhotsk; the watersheds of the Amur river and some rivers in the Khabarovskiy Kray; reach the upper streams of the Bol'shaya Ussurka, the Rudnaya rivers in the Primorskiy Kray, and the northern and the central parts of the Sakhalin Island.

The species' preferable biotops are fir and spruce-fir forests.

Population

In the late 1950s, the Siberian Grouse was a common, widely distributed species of the Khabarovskiy Kray (Roslyakov, 1985). However, since that time the population has decreaseed rapidly. In 1976, in the Khabarovskiy Kray the population size was approximately 15,000–20,000 individuals and in 1980–1981, it was some 12,000–15,000 (Roslyakov, 1985).

Causes of disappearance

Due to high food specialization (the major food source is fir needles) the species inhabits the fir and spruce-fir forests. In other forest formations the species live only temporary during migrations. Such affiliation by the Siberian Grouse to particular types of forest makes the species strongly vulnerable. Harvesting of these forests leads to complete disappearance of the species. Fires, hunting and people disturbance are among other factors causing the population decrease. As a result of all of these factors, the species has disappeared from the Baikal-Amur Railway zone (Roslyakov, 1985).

Protection measures

The following protection measures are required:

- creation of *Zakazniks* in areas with a concentration of the Siberian Grouse,
- restrictions on clearcutting of fir and spruce-fir forests,
- measures against forest fires and poaching, and
- artificial breeding.

6.5.5 Forest dynamics and successions of bird communities

Some bird species of the Russian Far East do not have a food specialization. Biotopical distribution of such birds depend on certain behavioral reactions, i.e., physiognomy of habitats (Kushnarev, 1984).

The virgin cedar-broadleaved forests of the Sikhote -Alin region are characterized by a multilayer and multielement structure, abundance of natural shelters and niches for bird diversity, and well-developed diverse undergrowth. The virgin broadleaved forests in valleys also have a complex and rich structure (Haritonov, 1978). Bird communities, inhabiting such forests, have a complex structure and are well distributed spatially (birds can be subdivided into crown, stem, and multilayer species).

Due to harvesting and uncontrolled fires, significant areas of the cedar-broadleaved forests of the Sikhote-Alin have been transformed into secondary broadleaved forests with lime, birch, and aspen as dominant species. These secondary forests are much poorer habitats, they have a single-layer structure and less plant species. This, in turn, leads to considerable changes in the bird communities.

Successional dynamics of the virgin coniferous-broadleaved forests to secondary, generally lime-broadleaved forests, is a common process in the Sikhote-Alin region. However, this process in its natural form, mainly caused by on-ground fires, takes centuries. Human activities have accelerated this process of forest alteration dramatically, due to selective harvesting of cedar and other coniferous species, and by crown fires induced by man.

General features of the formation of bird communities in the secondary broadleaved forests

The formation of bird communities in the secondary broadleaved forests is illustrated in Figure 13. According to Nazarenko (1971), the core of the ornithofauna of the secondary broadleaved forests is represented by birds of the virgin coniferous-broadleaved forests. examples of these birds are the Oriental Cuckoo (*Cuculus saturatus*), the Siberian Blue Robin (*Luscinia cyane*), the Grey-carred Woodpecker (*Dendrocopos canicapillis*), the Scaly Trush (*Zoothera dauma Latham*), and the Asian Stubtain Warbler (*Urosphena squameiceps*).

The remaining part of the bird communities in the secondary forests consists of birds with origin in the virgin broadleaved forests of valleys. Examples of these species are the Gray Wagtail (*Motacilla cinerea Tunstall*), the Yellow-breasted Bunting (*Emberizia elegans Temminck*), the Brown Shrike (*Lanius cristatus Linnaeus*), and the Azure-winged Magpie (*Cianopica cyanus Pallas*). At different stages of the forests succession different combinations of these bird communities can be represented.

Anthropogenic impacts (harvesting or human induced fires) promote a broad distribution of ecotone vegetation communities. As a result, significant changes of the bird communities will take place due to edge effects, changes in nutrition and habitat structures. Impacts of such changes on bird communities have been demonstrated by Simonov (1987) and are summarized in Table 7.

Table 7. Changes in bird populations at different stages of anthropogenic succession of cedar-broadleaved forests (in %).

Bird communities	Virgin cedar-broadleaved forest	Sparse cedar-broad-leaved forest in the first stage of succession after harvesting	Broadleaved forest in the final stage of succession after harvesting
Crown birds	34.2	20.7	20.3
Stem birds	11.5	7.8	7.8
Multilayer birds	14.8	9.5	5.4
Birds of undergrowth and bushes	39.5	62.0	66.5
Total number of individuals per km^2	475.3	507.8	586.8
Total number of species	30	23	19

Table 8. Total number of birds in different stages of virgin spruce-cedar-broadleaved forest (in Western Sikhote-Alin).

	Large-scale original virgin forest	Forest after selective harvesting	Isolated site in secondary (after fire) forest	Large-scale secondary (after fire) broadleaved forest
Total number of birds per km^2	229.4	162.1	87.0	226.7

Source: Kushnarev, 1984.

It can be seen from Table 7 that the total number of birds increases with changed successions, while the number of bird species is decreasing. The relative number of tree-layer birds (crown, stem, and multilayer birds) decreases, while the relative number of birds of undergrowth and bushes is increasing.

Comparative investigations of original and changed (by harvesting and forest fires) habitats have revealed that one of the most important factors for the formation of bird communities in the secondary broadleaved forests is the continuality of the forests (Kushnarev, 1984). In isolated forest patches the populations of all bird species decrease significantly (Table 8).

Changes in the winter bird communities

Forest alteration, caused by harvesting and fires, affects first of all the winter bird communities.

According to field observations (Charitonov, 1978) in the Middle Sikhote-Alin region, the winter bird communities changed significantly in numbers and species patterns in secondary forests in comparison with the virgin forests. Thus, the primary cedar-broadleaved and the broadleaved valley forests had the highest number of winter birds, 78 and 60 individuals per km^2. In secondary birch-aspen forests the representation was 42 individuals per km^2.

The structure of the winter bird communities is changing between primary and secondary forests due to elimination of some forest elements and transformation of bird habitats. For instance, the relative numbers of the winter crown birds (the Spotted Nutcracker and the Eurasian Jay), and the winter stem birds (the Eurasian Nuthatch) decrease in the secondary birch-aspen forests. At the same time, the multilayer birds (*PARIDAE* family) keep their absolute number and can even increase in relation to the total winter bird population (Haritonov, 1978; see also Figure 14).

6.5.6 Future trends in ornithofauna of Primorye

Due to the present intensive industrial development of the Russian Far East the environment is changing remarkably. Analyses of the distribution of the bird nestling during the period 1968–1978 in regions of the Bikin river basin and altered to different degrees resulted in the following conclusions (Pukinskiy, 1981b):

1. After logging, birds normally living in open or semi-open spaces and birds living near man find their optimal living conditions. The population of such birds increase, especially those having a superplastic behavior. Thus, the unique ornithofauna of Primorye is replaced by species which are sinanthropic or common for all of Europe. Before the logging of cedar-broadleaved forests, predatory birds like the *Pernis ptilorhynchus*, the *Butastur indicus*, and the *Accipiter virgatus* constituted the core of nestling birds. After the logging, other species, like the *Milvus korcshun*, the *Buteo buteo*, and the *Hypotriorchis subbuteo*, dominate the nestling. The owl *Ketupa Blakistoni* disappeared and the owl species *Ninox scutulata* and *Otus sunia* were replaced by *Asia otus* and *A. flammeus*. This process is common for other systematic groups of birds as well.

2. Birds which have an extended reproduction time appear to be able to handle different anthropogenic activities. Different species of the *Passerinoformes* family can serve as examples: *Phoenicurus auroreus, Emberizia spodocephala, Chloris sinica*, and others.

3. At all forms of harvesting (even selective or partial) very specific species of birds disappear first of all. These are birds using habitats of multilayer forest stands and this is especially true for riverland forests, which have a limited extent. These forests are of great importance being the main reserves and natural penetration paths of birds in the Kray. Intensive harvesting of such forests leads not only to impoverishment of ornithocenosises but also to undesirable qualitative changes of the fauna as a whole and to an introduction and broad distribution of new species.

6.5.7 Conclusions

The Primorskiy Kray hosts about 70% of bird diversity in Russia. Many of the bird species and the bird communities are strongly dependent on specific types of forests, mainly the cedar-broadleaved forests and different primary riverland forests. However, due to intensive harvesting and a large extent of forest fires these forests have changed significantly, which in turn has led to replacement of the unique ornithofauna in the Primorye.

The populations of highly specialized species have decreased rapidly and forced some of them to the verge of extinction (Fish Owl). Other bird species with a more wide adaptation range increased substantially. Despite the fact that the territory of the Primorskiy Kray is critical from the bird diversity point of view, there is limited attention by local (Russian) or international organizations to protect and conserve bird species and their ecosystems. Only by relevant protection measures, like prohibition on logging of certain tree species or types of forests, and creation of an extended network of protected areas (*Zapovedniks* and *Zakazniks*) the unique ornithofauna of Primorye can be saved.

7 Conclusions and Recommendations

Overexploitation of forest resources leads to serious losses of biodiversity. The most effective and efficient mechanism for conserving biodiversity is to prevent from the destruction and degradation of habitats. Every species is a part of an ecosystem, and plays a unique role in the ecosystem maintenance. To achieve variety of species, the conservation of ecosystems and landscapes is assumed to be one of the best methods.

Individual species may be special conservation targets of several reasons. Some of the species are so-called keystone species with especially important roles in ecosystems and may need to be assigned special conservation and protection. Others face great threat from over-exploitation, human disturbances, and changing environment. Some have big aesthetic and other values, the Amur tiger and the Amur leopard belong to such species.

For endangered species, conservation and protection measures must be carried out by a wide array of supplementary approaches. The measures can range from increased level of habitat

protection and species-management programs in the wild and semi-wild conditions to off-site protection in zoos, botanical gardens, and in gene banks. In other words, an integrated approach must be applied in each particular case.

This report has attempted to give an assessment of the influence of the industrial forest exploitation on forest-dwelling species of vertabrates in the Russian Far East. The Amur tiger, the Amur leopard, the Himalayan black bear, four endandered birds species, and changes in forest-dwelling bird communities, were chosen as examples representing key-stone species.

The sizes of species populations and distribution dynamics, causes of extinction, and relationships to different forest management practices were analyzed. Assessments of existing protection measures have been made, and future protection and conservation measures are proposed.

From this study the following conclusions and recommendations can be made.

7.1 Conclusions

- The Far East is a unique region, having the highest level of species diversity in Russia. It is the only refugee of two big cats, the Amur tiger and the Amur leopard (both of them are listed in the IUCN Red Book), and is the richest region of Russia in term of bird species. Therefore, conservation of species and biodiversity is a problem of national and international concern.

- The existing system of protected areas in the Far East can not support the maintenance of the species in situ. Therefore, creation of additional protected areas must be undertaken in order to provide habitat areas for the species and corridors for migration paths.

- Recent economic development paths, oriented toward intensified forest industrialization in the region are threatening the biodiversity. Intensive harvesting conducted by the Russian forest industry over time has detrimented wild populations of animals. However, international timber corporations presently operating in the region could further destroy the threatened populations by using large-scale clearcutting.

- The legislative basis and control measures for conservation of biological species are too weak and too inefficient in Russia with respect to poaching and destruction of species habitats.

- International financial support for economic development of the Russian Far East and for biodiversity conservation are in contradiction and are not mutually coordinated.

- Considerable efforts have been made by scientists from the Far East Division of the Russian Academy of Sciences and the US Hornocker Wildlife Institute for elaboration of the Amur Tiger Conservation Plan.

- A similar plan for conservation of the Amur leopard is not completed yet.

- The Himalayan black bear population is decreasing rapidly and without effective protection measures the species is a pretendant for a Critically Endangered status.

- Primorskiy Kray hosts around 70% of the bird diversity of Russia. However, individual bird species and whole bird communities are suffering from non-sustainable forest exploitation and absence of control measures. The process of replacing a unique ornithofauna by common European species is taking place in Primorye.

7.2 Recommendations

- To protect the unique biodiversity of the region the number and areas of *Zapovednik*s should be increased. Provisional reserves may be some of the existing areas of federal and local *Zakazniks*. The existing management regimes for the *Zakazniks* should be reviewed

and changed. A set of National Parks should be established in the Far East in order to increase the protected area network.

- The strategy for the industrial development of the forest sector should be reviewed and should take the biodiversity status in the region into account. All large-scale clearcutting should be restricted, small-scale clearcutting and selective cutting should be adopted only after environmental impact assessments.
- Strong restrictive legislation and tax measures should be undertaken in order to diminish illegal harvests.
- Areas of leopard and tiger habitats should be designated for highest category of protection.
- A four-party agreement on the principles of forest exploitation should be elaborated and signed by the Russian forest industry, major foreign forestry investment groups, international biodiversity conservation projects, and the Far Eastern government. The agreement should be widely published and discussed.
- The Amur Tiger Conservation plan should be approved by the Federal Russian Government and its implementation should be supported by local authorities.
- A Leopard Conservation plan should be developed by coordinative efforts of international field biologists, geneticists, government authorities, and the forest service structures.
- Special attention should be paid to protection and conservation measures of unique forest complexes and individual bird species in Primorye. In addition to restrictions on logging of certain types of forests, the number of protected areas concerning specific birds should be created in order to save the unique ornithofauna.

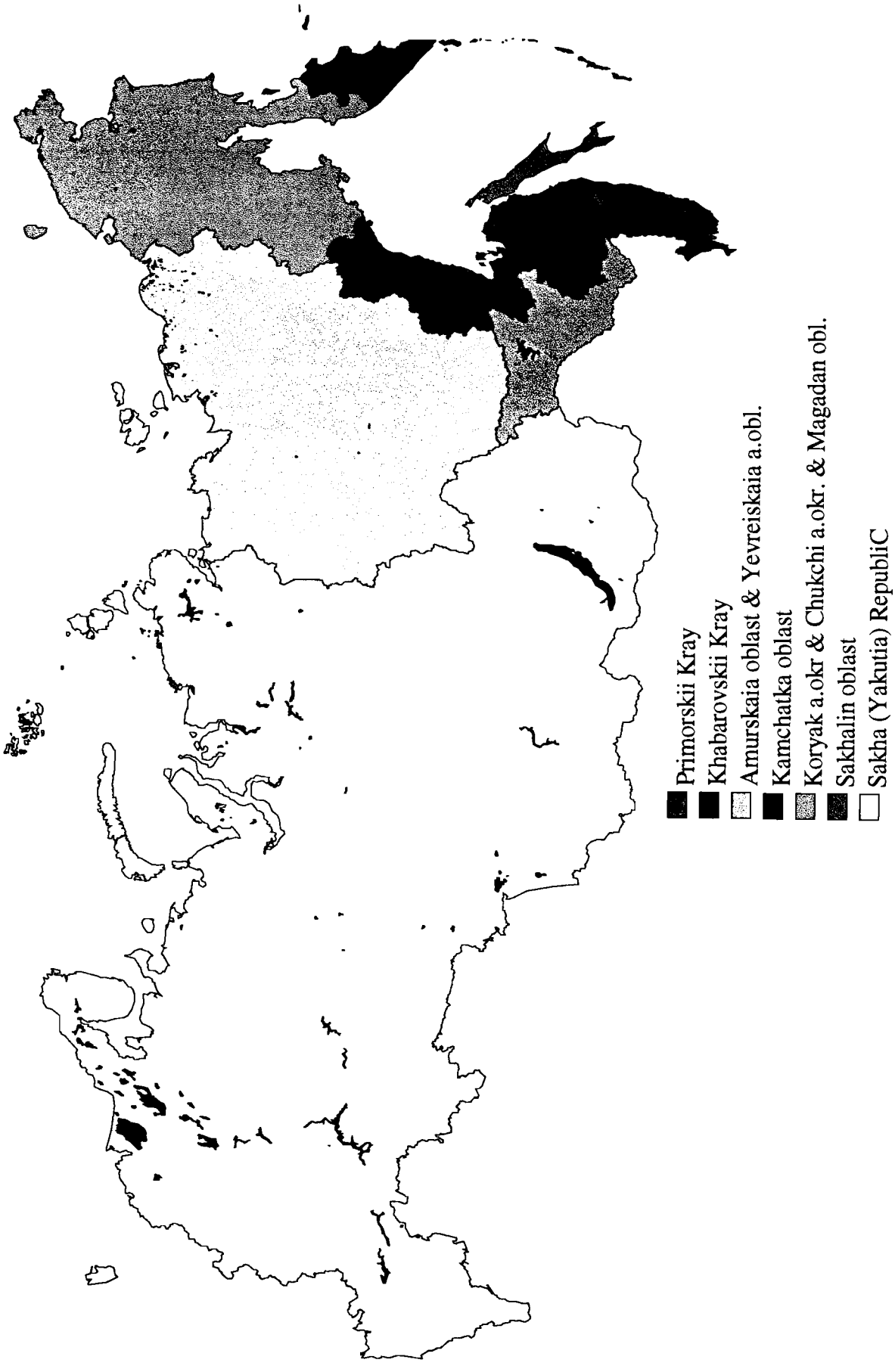


Figure 1. The Far East economic region of Russia.

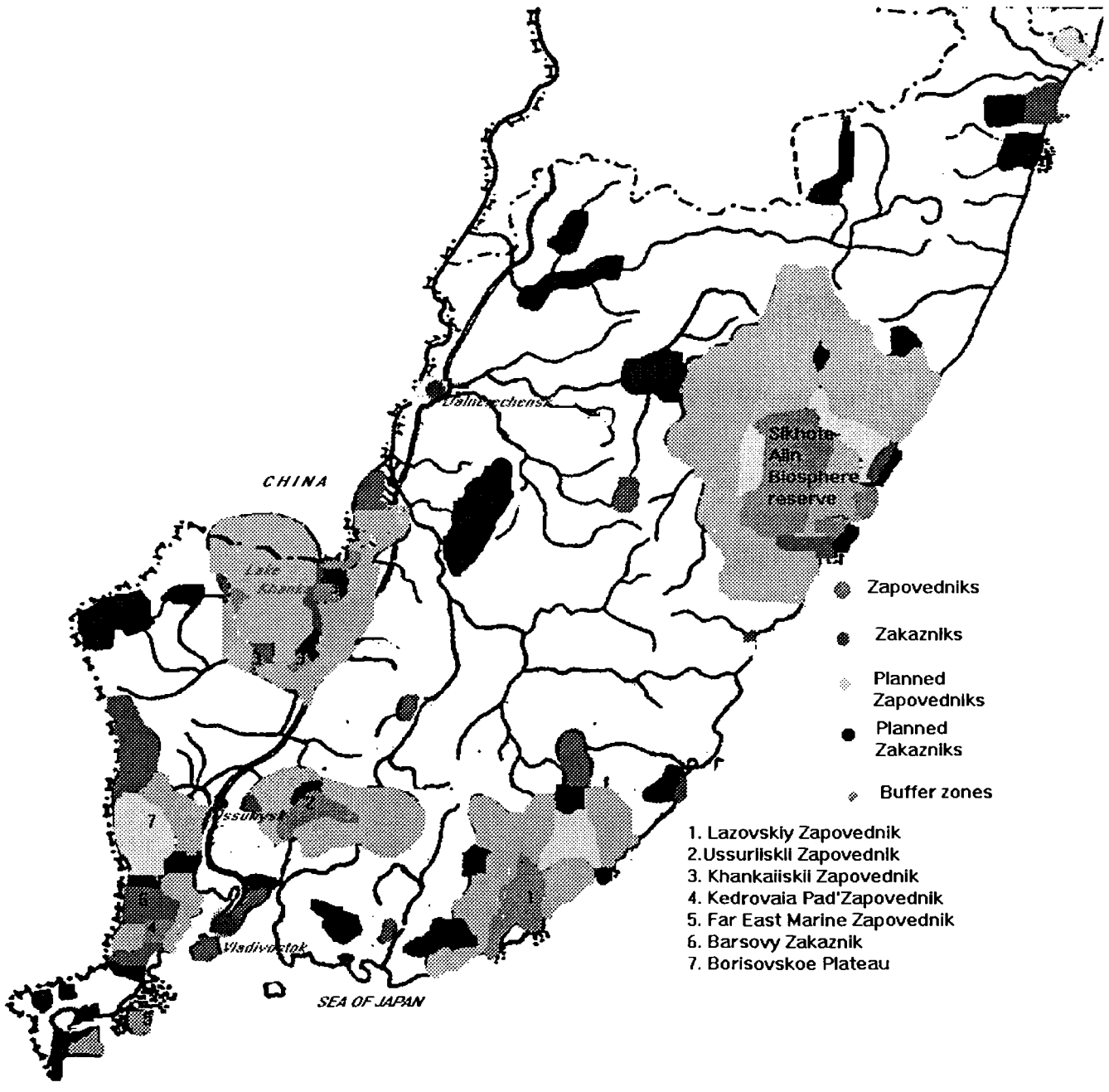


Figure 2. Existing and recommended protected areas in Primorskiy Kray.

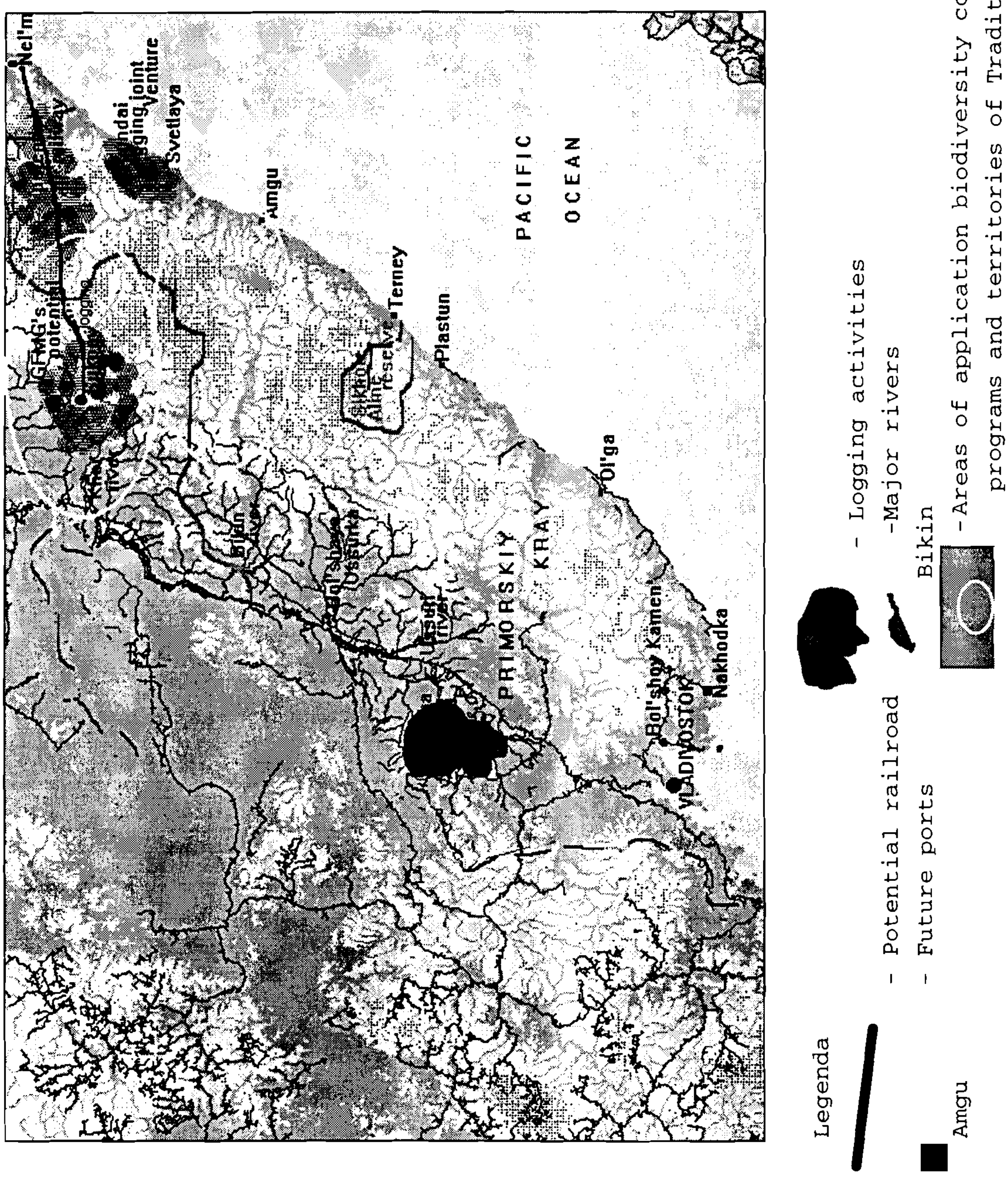


Figure 3. Location of some of the international logging activities, future ports, and biodiversity conservation programs.

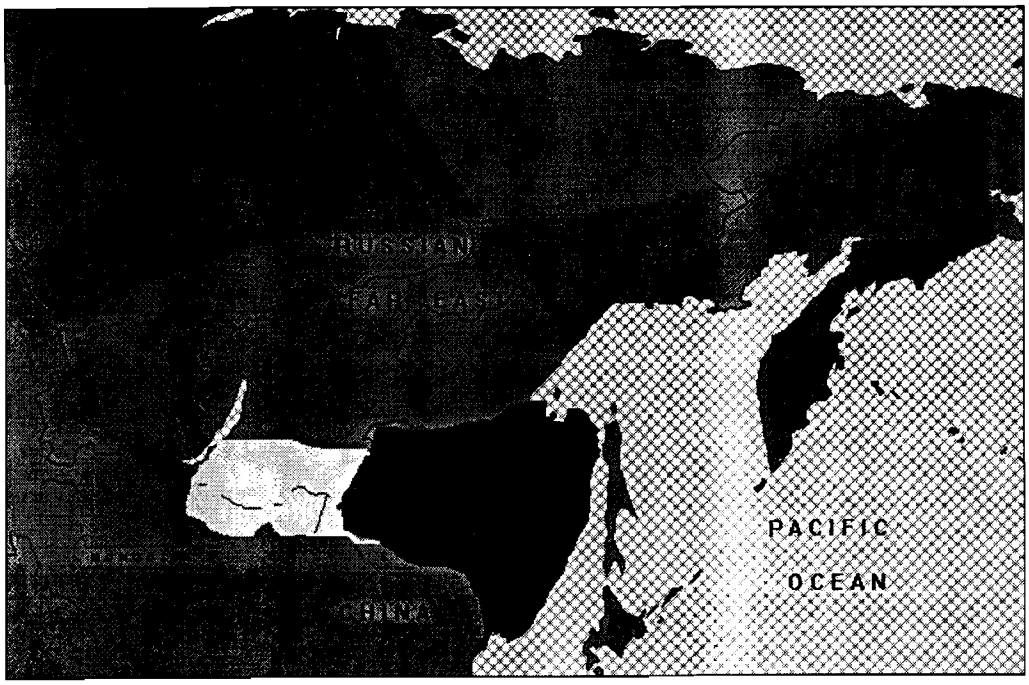


Figure 4. Geographical distribution of the Amur tiger at the end of the 19th century.

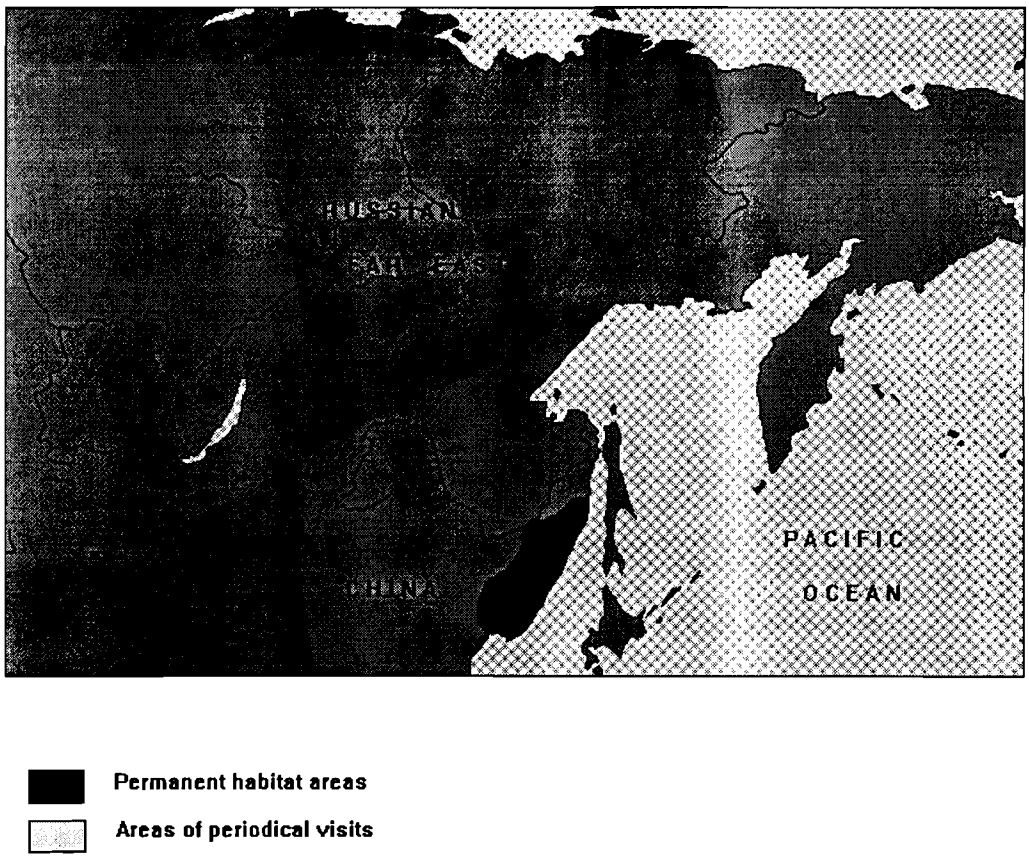


Figure 5. Geographical distribution of the Amur tiger at present.

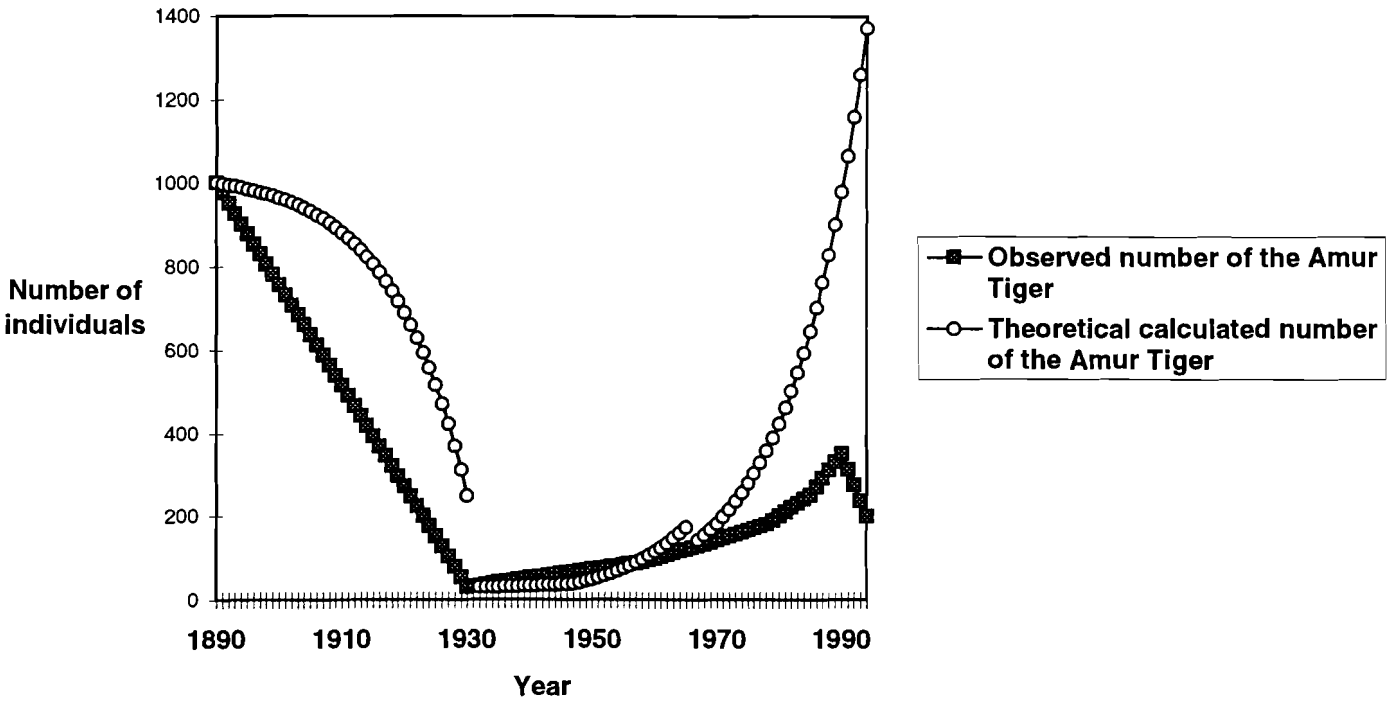


Figure 6. Dynamics of the Amur tiger population in the Russian Far East.

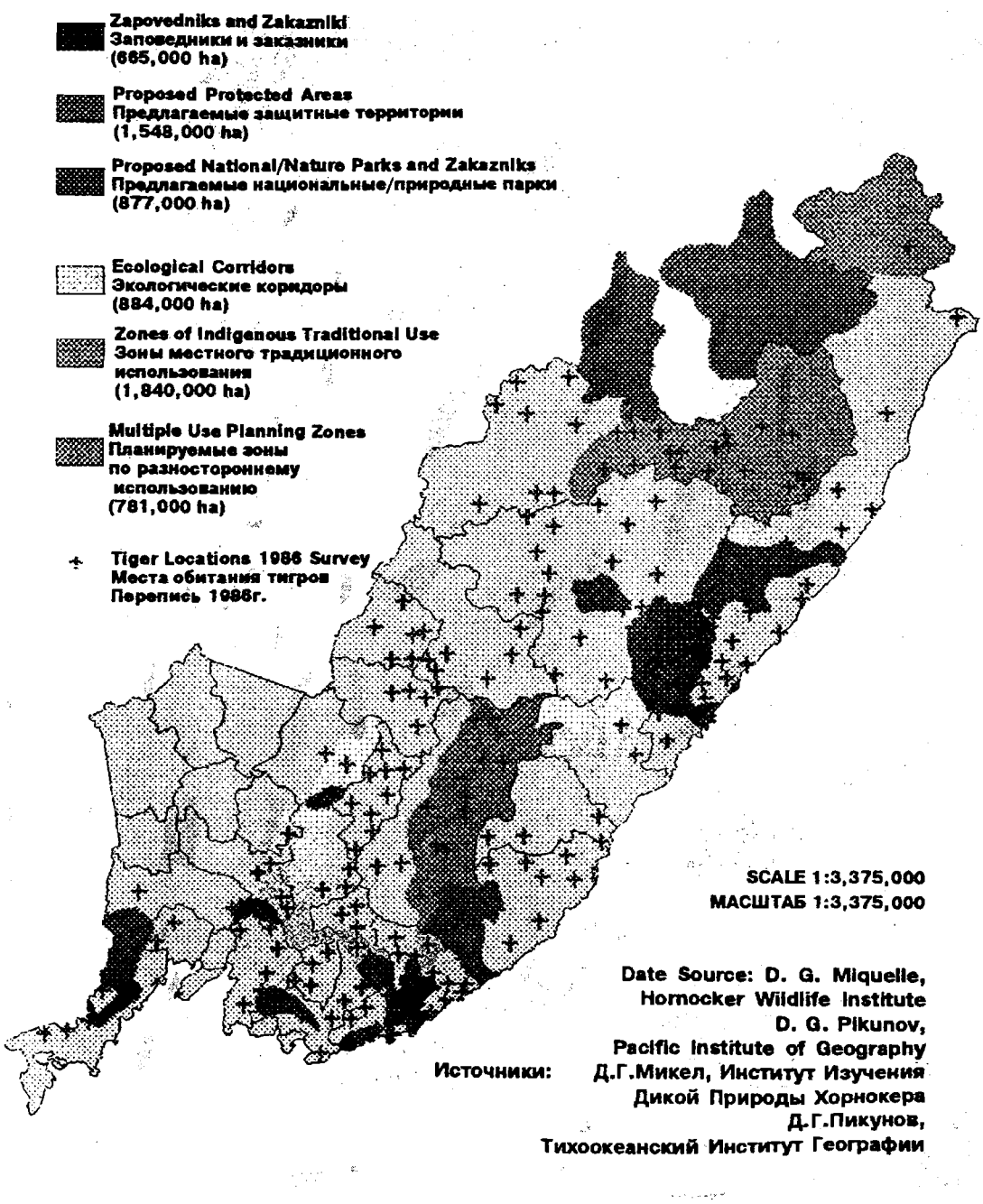


Figure 7. Amur tiger conservation plan: Network of core areas.

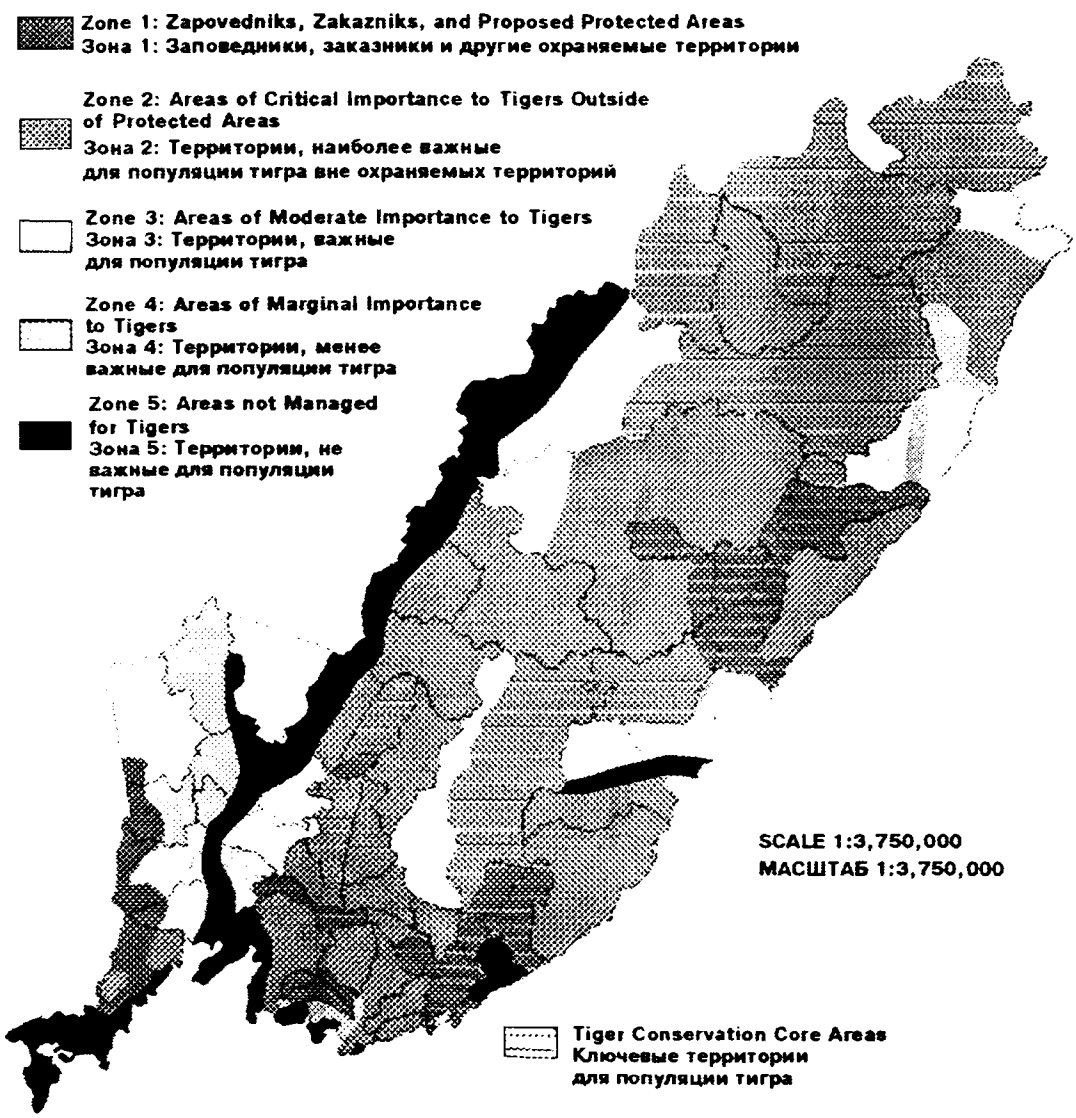
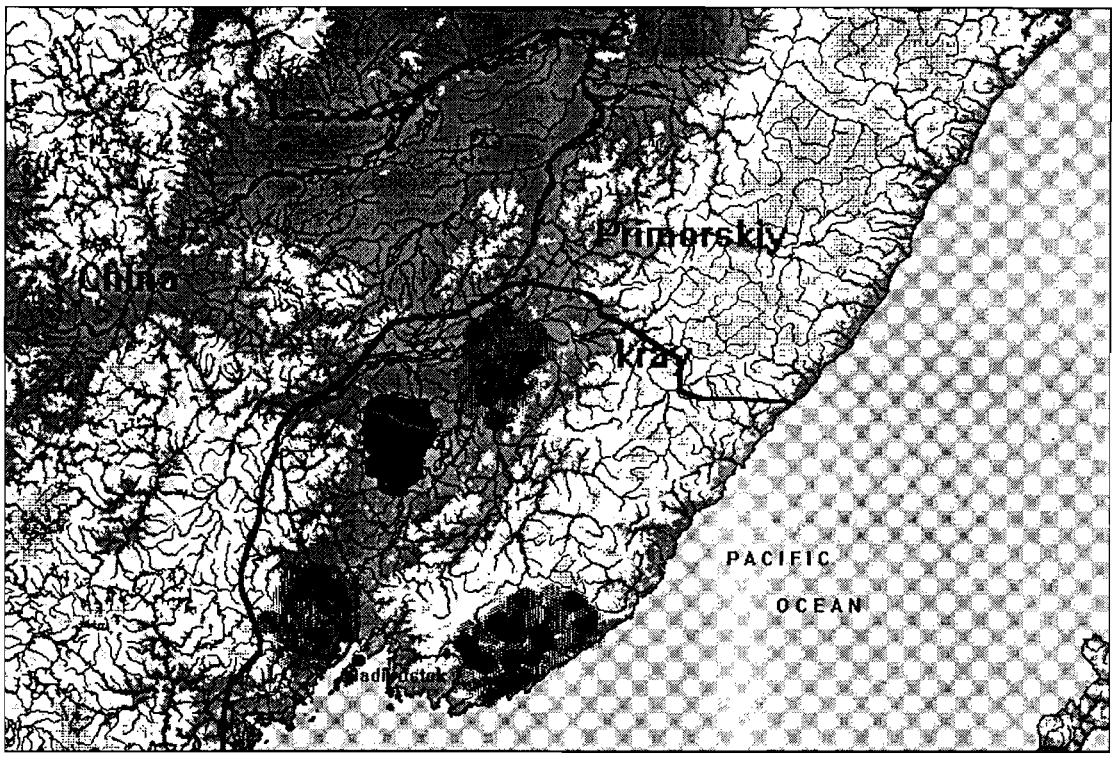


Figure 8. Amur tiger conservation plan: Zonings of land based on importance to tiger conservation.



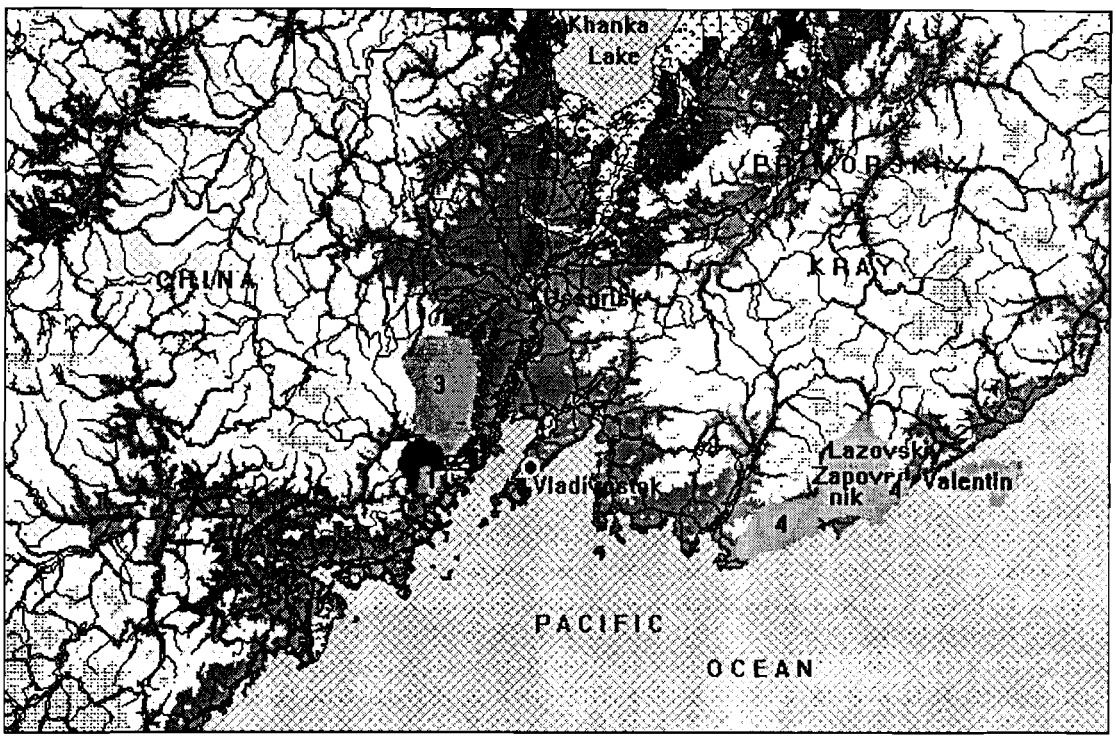
Legenda

- Border of the leopard distribution in XIX century

- Habitat areas in 1970s:
  1. Sikhote-Alin habitat area
  2. North-Western habitat area
  3. South-Western habitat area

- Present habitat area

Figure 9. Geographical distribution of the Amur leopard.

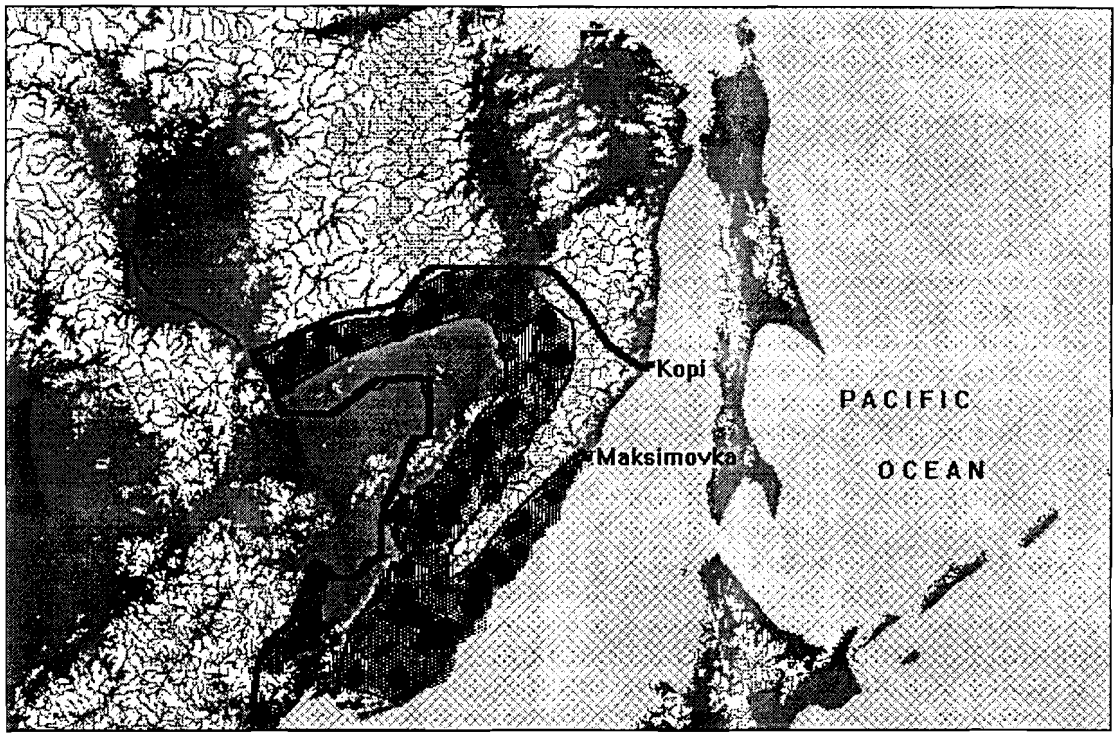


Legenda

- 1 - Kedrovaya Pad' Zapovednik
- 2 - Barsovy Zakaznik
- 3 - Borisovskoe Plateau
- 4 - Areas perspective for restoration (former Sikhote-Alin habitat area)
- — - Potential area for expansion of Barsovy Zakaznik

Scale 1 cm: 35.7 km

Figure 10. Amur leopard: Existing and future protected areas.



Legenda

- Habitat area, according to Sysoev, 1957

- Habitat area, according to Bromley, 1965 and Kucherenko, 1977

Figure 11. Geographical distribution of the Himalayan black bear in the Russian Far East.

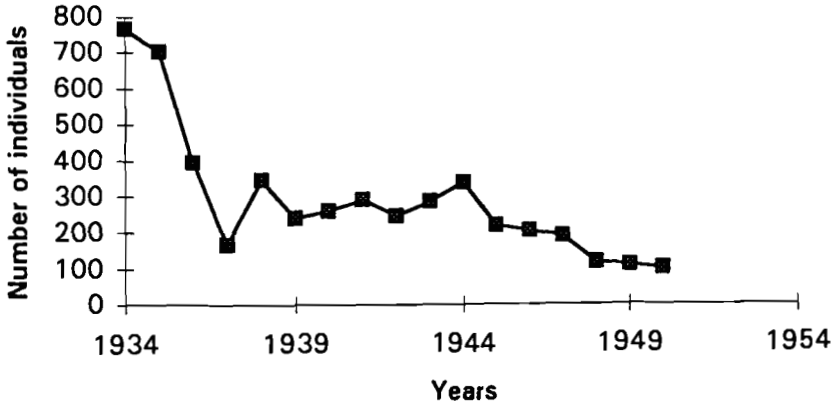


Figure 12. Commercial purchases of two species of bear in the Russian Far East. Source: Bromley, 1965, Table 15.

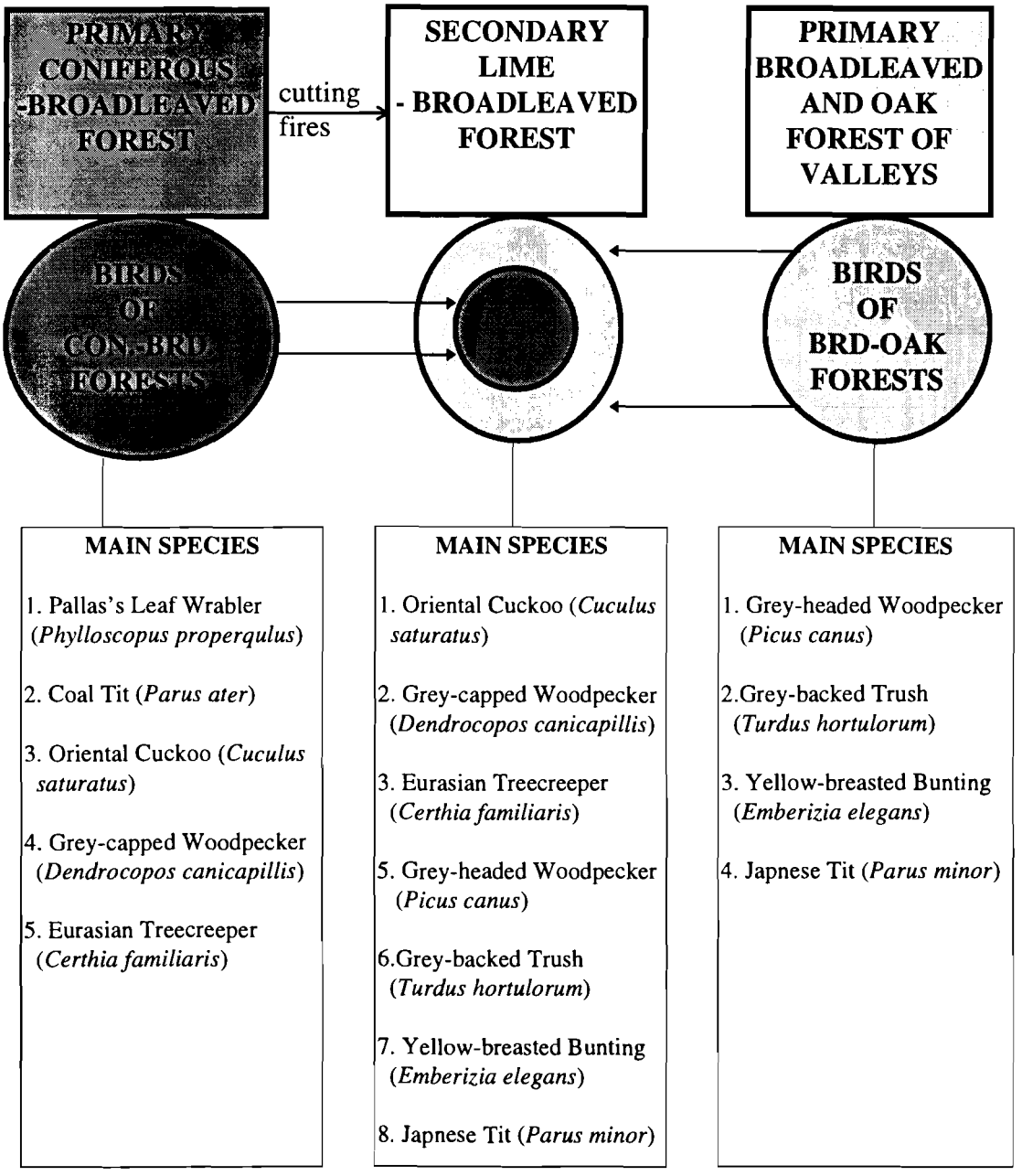


Figure 13. The formation of bird communities in the secondary lime-broadleaved forests in the Primorskiy Kray.

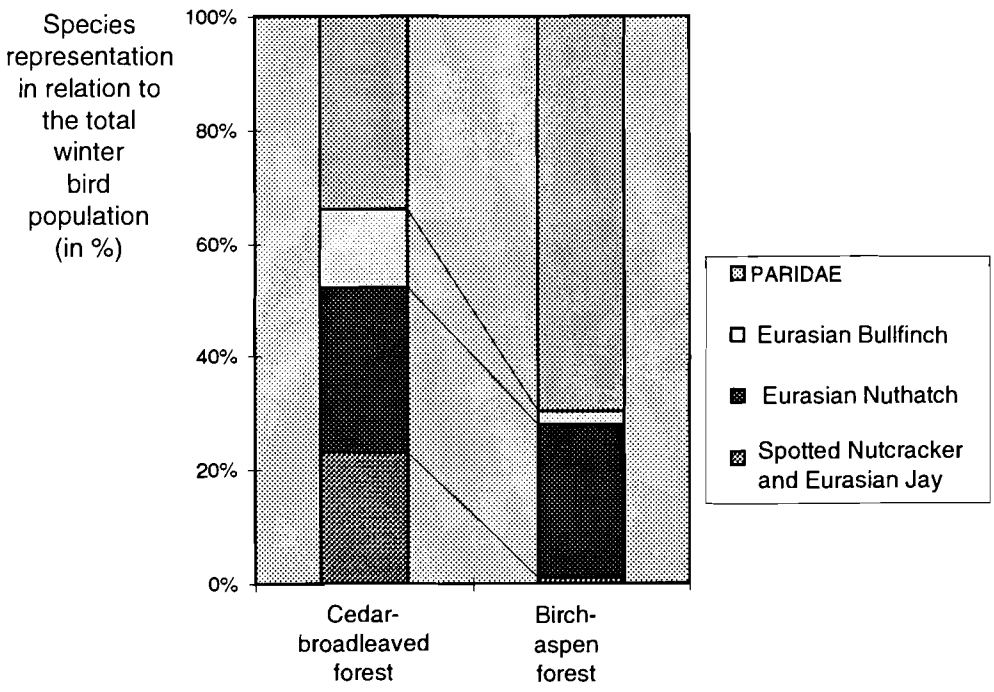


Figure 14. Changes in the winter bird communities due to alteration of primary cedar-broadleaved forest to the secondary birch-aspen forest in the Sikhote-Alin. Source: The figure is constructed according to data given by Haritonov, 1978.

Appendix

Calculation of the theoretical dynamics of the Amur tiger in the Russian Far East

Assumption: *The habitat destruction and fragmentation do not affect the Amur tiger population.* In this case, the possible dynamics of the Amur tiger can be calculated in the following way.

The dynamics can be described by two processes:

- the process of natural growth and mortality of the population (Svirezhev and Logofet. 1974),

$$N_{\text{natural}} = N_0 * \exp((\alpha - \beta) * t) \quad ,$$

where α is the annual rate of birth, β is the annual rate of mortality, t is the number of years passed, N_0 is the initial number of the tiger population, N_{natural} is the number of population after t years

- the poaching impact is assumed to be linear over time:

$$N = N_{\text{natural}} - K * t \quad ;$$

where K is the annual number of hunted tigers, N is the remaining number of individuals in the tiger population.

According to Yudakov and Nikolaev (1987), the birth rate of the Amur tiger is 3 cubs in four years per female tiger or 0.75 cubs annually per female and the annual mortality of just born cubs is 50% or 0.325 cubs per year. So, β is equal to 0.375.

The annual adult mortality is estimated to 13% in the entire tiger population. Therefore, the annual mortality rate β for females will be 0.26, and it can be estimated that the growth of the tiger population is:

$$N_{\text{natural}} = N_0 * \exp((0.375 - 0.26) * t) \quad .$$

The total time period studied is divided into three intervals, according to poaching scale and available data (see section 5.2):

1. from 1890 to 1930 annual number of tiger killed, K, is estimated to be 90,
2. from 1930 to 1947 around thirty tigers were killed, so K is estimated to be approximately 2.4 cats per year,
3. from 1947 the tiger poaching was prohibited and K is set to zero.

Results of the calculations are shown in Figure 6.

Explanations:

1. Up to 1890 the tiger population was stable and oscillated around 1000 individuals. The theoretical number of tigers in 1930 is considerably higher than the observed one. It can be explained by the habitat degradation caused by the rapid economic development of the region during that time.
2. The interval from 1930 to 1967 is characterised by a stable increase of the tiger population with roughtly the same values in the theoretical and the observed cases.
3. The calculated values for the time period 1967–1996 are also significantly higher then observed. This difference is most likely caused by habitat destruction and fragmentation, and illegal hunting simultaneously.

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